The

# Tropical Agriculturist

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## EDITORIAL

THE recent investigations of the Committee on Soil Erosion have kept the question of soil erosion prominently before local agriculturists and it is to be hoped that Mr. Felsinger's further account in the following pages of the system of drainage which he practises will be of interest. It will be noted that Mr. Felsinger lays stress on the importance of the conservation of soil moisture and rightly so, since the conservation of moisture is intimately related to the question of soil erosion and soil fertility. It is not intended to criticise Mr. Felsinger's system of drainage, but it may be said that it has been borne upon the Committee on Soil Erosion that the primary aim of all measures of soil conservation should be the reduction of the erosive action of run-off water and the prevention of the downward movement of the soil on the slopes which are so common in the tea and rubber districts of Ceylon. It may be argued, therefore, that the primary function of a system of drains or pits is that of holding up surface water and allowing it to seep into the land rather than that of holding up eroded soil so that it may be returned to the land or that of leading surface water off the land as rapidly as possible. This view is gaining ground and it follows that from the point of view of erosion a system of drains should be considered as only a second line of defence. The first line of defence should be found in the protection of the soil from the beating and erosive action of rain water by the provision of ground cover and high shade, particularly ground cover.

These points will doubtless be elaborated in the report of the Committee on Soil Erosion. It is proposed at present merely to draw attention to the importance of ground cover and to appeal to the agriculturists of the island to bring forward their views through these pages. Opinions differ regarding, for example, anti-erosive planting systems and the use of non-leguminous plants as ground covers, and it is hoped that planters who have experimented and have results to relate will follow the example of Messrs. Denham Till and Marsh-Smith in the December number of this journal and of Mr. Felsinger and Mr. Roy Bertrand in the present number. Mr. Roy Bertrand, again, has suggested discussion of the difficulties of modifying the old herring-bone system of drainage in accordance with modern ideas and of growing cover plants, leguminous or other, on old estates, the soil of which is deficient in humus, but discussion need not be confined to matters of soil conservation. The problems of budding, seed selection and rejuvenation of old areas of rubber will loom large in the coming years and the questions of conservation of soil moisture in the drier coconut areas and of green manuring of coconuts are of great interest. *The Tropical Agriculturist* will be glad to open its columns to articles or correspondence on these matters.

# CONSERVATION OF SOIL AND WATER.

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TWO simple methods have been adopted here and on other places the writer is interested in. While it is not held that either does away with the handicap which land opened on the old style suffers, they are both useful and have been found to increase yields by a statistically noticeable amount.

1. When drains come up for deepening they are not cut to the full depth throughout their length. Sections about 8 feet in length are deepened leaving blocks of 2 feet uncut. Such blocks should of course not be left so high as to cause the drain to overflow. The effect of this system is to convert each drain, at less than the ordinary cost of deepening, into a series of water-traps.

2. In the autumn it is the custom here to cut two pits per chain of drains. The pits measure 6 ft. by $1\frac{1}{2}$ ft. by 2 ft. deep (below the bottom of the drain). These pits are left open until the wintering is over; then, in April, surplus women and children are employed sweeping all the leaves from the drain and from 2 feet on each side of it into these pits. The leaves are *thoroughly well mixed* with a little of the red earth and are tramped down. The top layer is sprinkled with from 2 to 3 lb. of cyanamide to promote breaking down.

These "sponge-pits," as they are called, soon become invaded by masses of roots. Their effect is particularly noticeable during droughts, more so should, during that time, a short heavy shower fall, the majority of which is usually shot off the land.

The distances given are approximate. It is a mistake to cut more holes than the leaves in the drains only will fill unless there is green manure or jungle stuff handy.

The method has the additional advantage that clearing of drains may be started before the heavy rains which usually carry off so much valuable leaf begin.

# A FURTHER MEMORANDUM ON THE DRAINING OF HILLY LANDS WITH A VIEW TO REDUCING SOIL EROSION.

E. O. FELSINGER,

PRIMROSE HILL, PERADENIYA, AND FRUITHILL, HATTON.

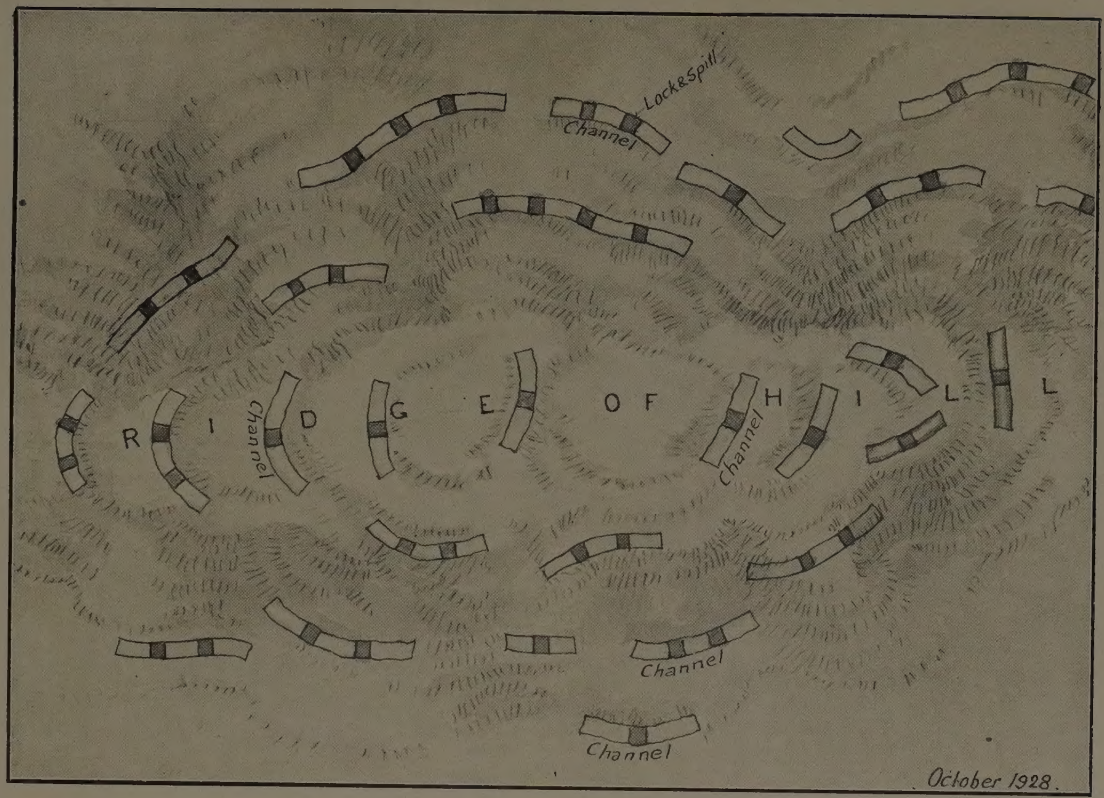
## PART 1.

IN a previous memorandum published in *The Tropical Agriculturist* for October 1928, I explained a system of drainage I recommended for adoption on up-country estates in general. Further experience, and a further consideration of the matter, have convinced me that it is possible and desirable to devise means for holding up rain-water at the highest levels with a view to arresting its uninterrupted flow down the slope. The advantage of such a device is two-fold inasmuch as it will not only serve to further minimise loss by erosion in localities where the rainfall is excessive but also store up water in situations in which it will prove most useful in localities where the rainfall is comparatively low or the land is subject to periodic drought.

Diagram A illustrates my method of providing a series of what I have called channels, but which are more in the nature of little reservoirs, at the highest point of the ridge or crest of a hill and the area immediately surrounding it, each channel having its own lock-and-spill system.

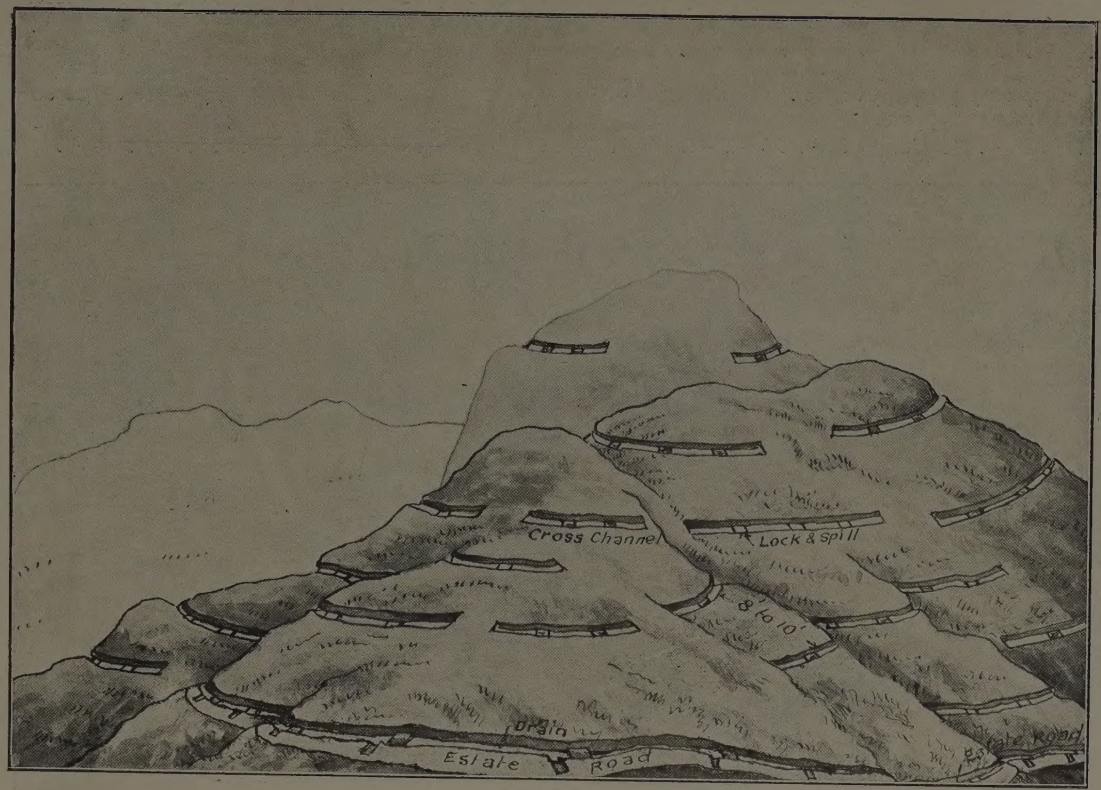
Where the rainfall is comparatively low and there is, as is generally the case, a tendency for the higher elevation to suffer from lack of adequate moisture, this plan will help to hold up water where it is best calculated to benefit the land by slow percolation through the soil to the areas lying immediately below the channels. The benefits of this plan will be most apparent during periods when no rain falls. With hilly lands the aim should be to store up the rain at as high a level as possible and to serve the land in the immediate vicinity which is most liable to be bereft of moisture, owing to the tendency of water to run down a slope. Once water finds its way to the lower levels, it becomes useless to the land at the top. The object, therefore, should be to keep as much as possible of the rain that falls by capturing it in traps in the region which will most benefit by it. But, as I have said above, a system of channels provided on hilltops will also prove of material advantage in localities where the rainfall is excessive, since it will serve as a check or brake by reducing the volume of the downward flow of water and thus minimising erosion.

## DIAGRAM A.




Channels 12 in. to 18 in. wide by 12 in. to 18 in. deep provided with locks and spills 6 to 8 feet apart. Suitable for average rainfall below 100 inches.

## DIAGRAM B.



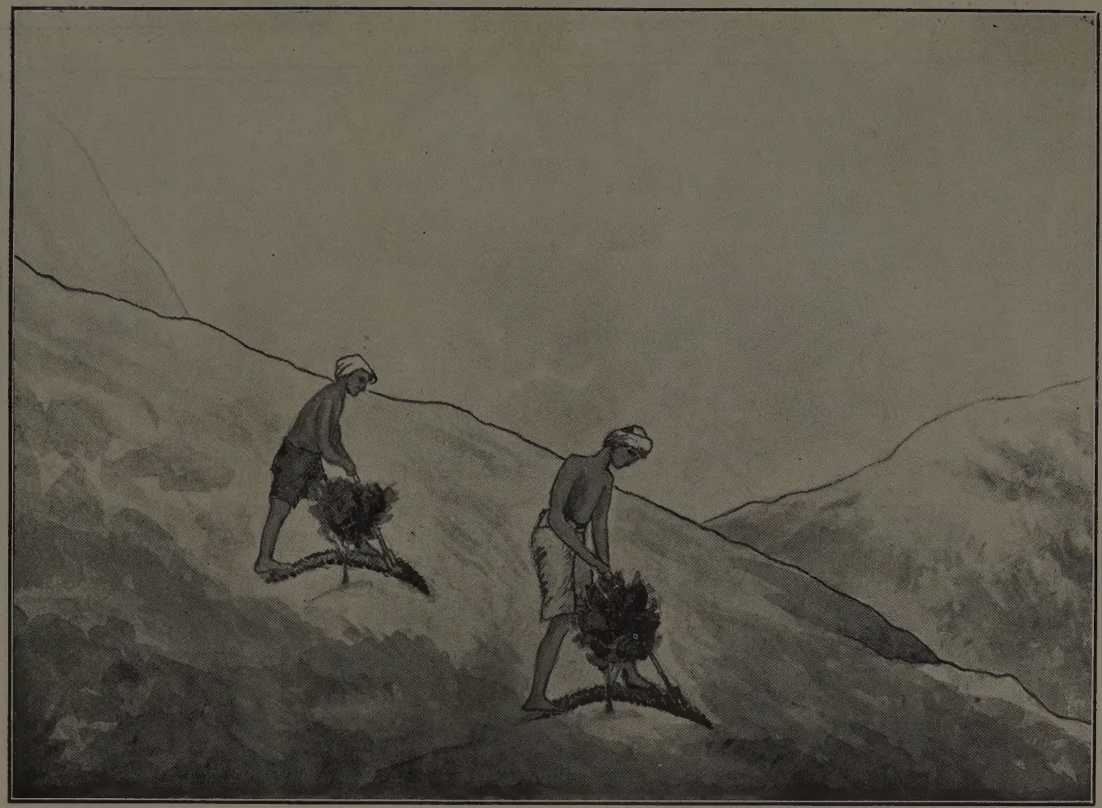

Cross channels 12 in. to 18 in. wide by 12 in. to 18 in. deep. Locks 1 foot by 1 foot placed 8 to 10 feet apart. Estate road 4 to 5 feet wide, gradient 1 in 30 to 40. Estate road drain 1 foot wide by 1 foot deep.

This system of drainage on hilly or undulating land is suitable for average rainfall below 100 inches. The channels impede and arrest the flow of water and prevent accumulated rush downward and also conserve the soil deposits and manure.

Cross channels 12 in. to 18 in. wide by 12 in. to 18 in. deep. Gradient 1 in 30 to 40. Locks and spills 6 to 8 feet apart. Space between channels 12 to 15 feet. Estate roads 4 to 5 feet wide. Cross drains on estate roads 3 to $3\frac{1}{2}$ feet long by 18 inches wide. Estate road drain 1 foot wide by 1 foot deep.

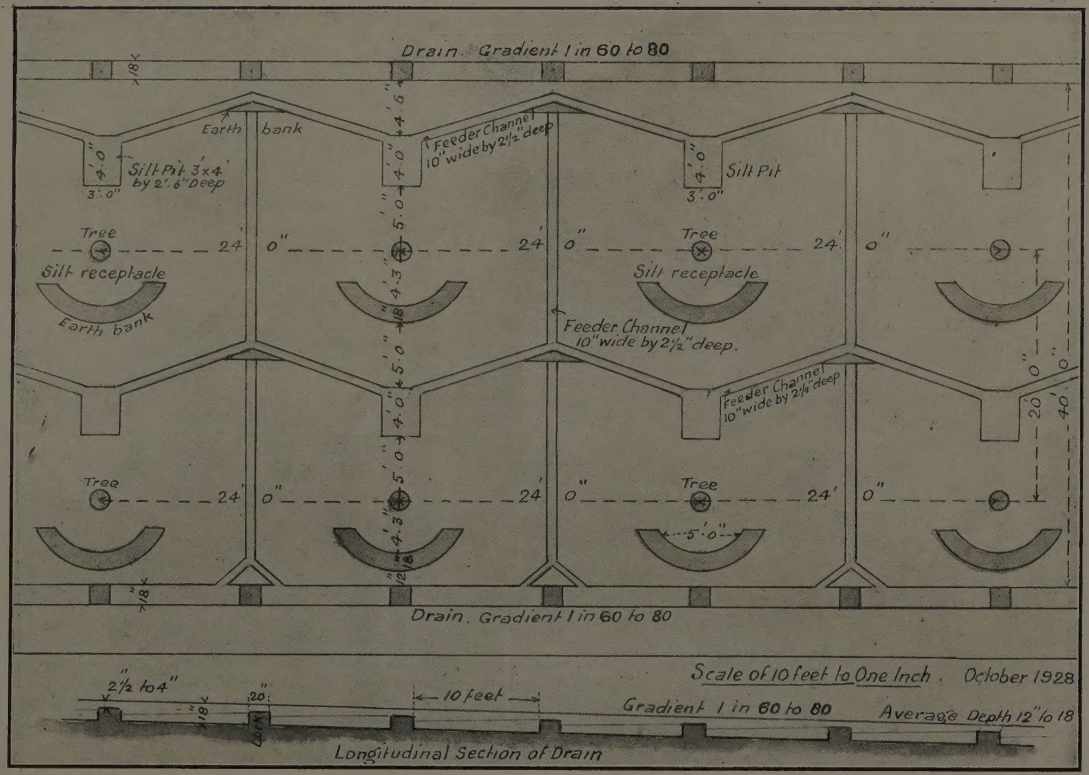
This system of drainage on hilly and undulating land is suitable for over 100 inches rainfall as it is calculated to impede and arrest the flow of water and prevent accumulated rush downward and also hold in suspension the deposits of soil and manure. The height of these hills is from 500 to 1000 feet from base with a slope of 40 to 60 degrees. The cost of drains 18 in. × 18 in. new clearings is Re. 1·25 (contract rate) but if done by estate coolies will cost 50 to 60 cents per chain. The clearing out of drains may be done once a year at a cost of 30 cents per chain.

DIAGRAM D.



Forking in manure crosswise over a crescent-shaped space, 6 to 8 ins. wide, about 1 foot above the tea bush.

## DIAGRAM E.




System of drainage and silt-pits for old rubber and coconuts on hilly and undulating land.

Drain gradient, 1 in 60 to 80. Silt-pit 3 ft. × 4 ft. by 2 ft. 6 in. deep. Feeder channel 10 in wide by 2½ in. deep. Rubber 20 to 25 feet apart. Coconut 26 to 28 feet apart.

The cost of these silt-pits and the small drains leading to them is 18 to 20 cents per tree.

Diagram B shows how rain-water can be held up along side-drains in localties where rain is not plentiful and droughts occur, by providing catch-pits dug crosswise to retain water.

Diagram C is a general view of a hillside, showing my lock-and-spill system of drainage for up-country estates, particularly where the rainfall is excessive. For a full account of this system and its advantages see my first memorandum on this subject in *The Tropical Agriculturist* of October, 1928.

Diagram D illustrates my method of applying and forking in manure with the least risk of loss during unexpected heavy rain. The manure is spread over a crescent-shaped area, six to eight inches wide at the centre, about a foot above the tea-bush, and the forking is done crosswise. The ordinary method of forking downwards is bound to result in the loss of valuable fertilising elements by severe wash which will be saved by my method.

## PART 2.

It is a well-known fact that the output of coconuts is largely dependent on weather conditions. A season of copious rain induces a good "flush" of blossom and a subsequent heavy crop of nuts while a spell of drought invariably results in reduced crops. Rubber also thrives best with a heavy, abundant and regular supply of moisture. Under dry conditions the latex-yield is low. The object of the coconut and rubber planter should therefore be to conserve the rain that falls on the land and make it go as far as possible in maintaining a regular supply of moisture for the roots. To this end as little as possible of it should be allowed to leave the land, and what is retained should be utilised to the best advantage. I have devised two methods, one for old plantations, the other for young estates, with a view to making the most of rain-water for the benefit of the cultivated trees and at the same time reducing any tendency to soil erosion to a minimum.

In diagram E, I have tried to show my method of drainage for old plantations. The dimensions of drains, catch-pits, etc., are given in the diagram, but a word or two of explanation is necessary to make the scheme quite clear. It will be seen that at a distance of 5 feet on the upper side of each tree there is a pit for catching water and such silt as it brings with it. The construction of this pit will necessitate the cutting of some roots, but this will be more than compensated for by the advantages gained. Water is led to the pit by two shallow feeder drains. The silt which is brought in is, whenever found necessary, removed and used for forming an earth-bank, curved in shape, about 4 feet 6 inches away from the tree on the lower side. In laying down the earth-bank it is necessary to first dig up the area on which the earth is to be laid, so that the bank will thereby gain stability by becoming incorporated with the soil on the ground.

Perpendicular feeder channels are also cut midway between the trees, and these catch up water and conduct it to the branch feeder drains. By this means there is a uniform distribution of water over the whole land. In rainy weather the ultimate outflow will be along the transverse drains, which are provided with locks and spills to further control the flow and prevent the removal of silt. On the other hand, when there is no rain the water stored in the pits will by a process of drainage furnish moisture to the trees and so promote their healthy growth.

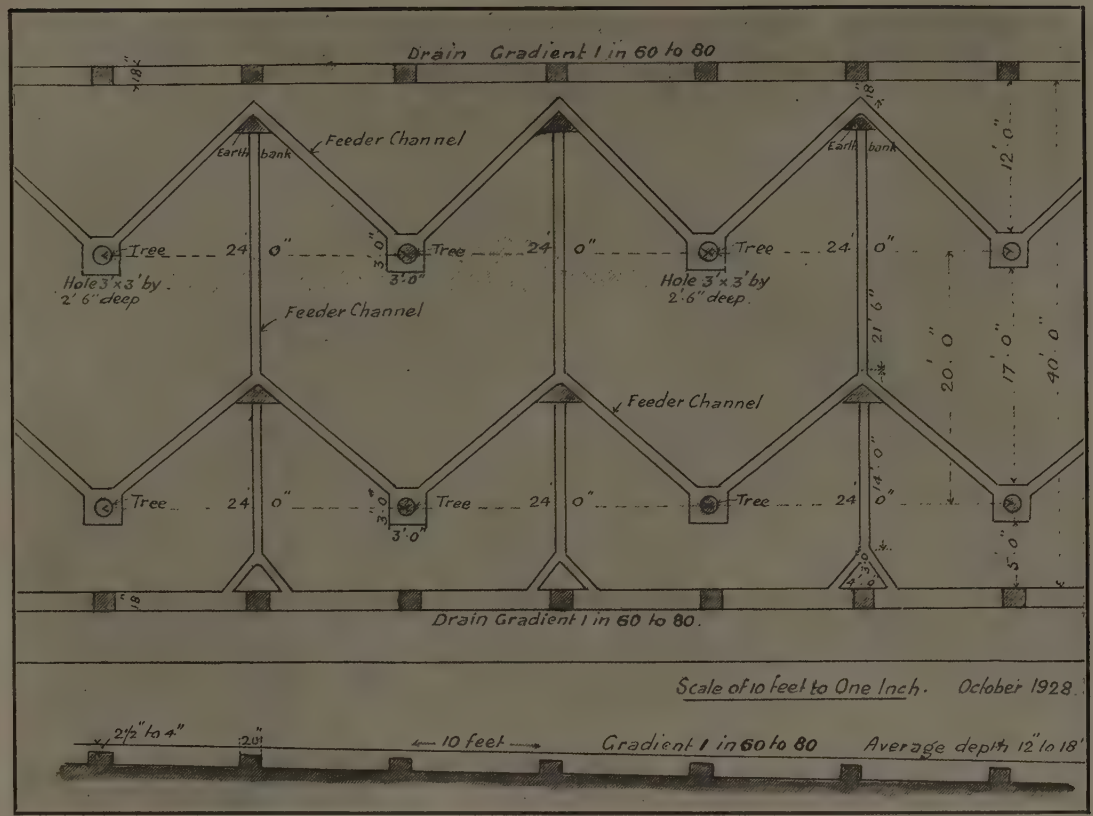
Diagram F illustrates a slightly modified method intended for young plantations. Here the arrangement of the feeder drains is practically the same, but instead of the water being led to a pit it is directed to the young plant itself. It is in the young stage that moisture is most needed for rapid development, and the silt and water brought to the cocount hole tends to promote the growth of the plant and bring it to early maturity.

When the plant is found to be getting clogged up with silt, it will be necessary to clear the hole of the excess. In case of heavy rain a small pit 18 in. × 18 in. × 18 in. placed eighteen inches above the plant will prevent an excessive accumulation of water. The relative distances between trees given in the diagrams are not absolute but are adaptable to varying conditions of soil, crop, etc.

One of the most important details in tropical agriculture is the proper control of tropical rains. Under ordinary conditions of cultivation not only do we lose much of the benefits of our rainfall, but suffer the damage which it is capable of causing by erosion. The methods I have explained above are calculated not only to conserve rain-water for the plant but also to prevent such damage. In this way the fertility of cultivated land will be maintained as far as possible by not allowing silt, composed of the best part of the soil, to be carried away.

The system on which these methods are based is a combination of drainage and irrigation and is calculated to make the fullest and best use of the rain-water that falls on the land. For this reason I think these methods should commend themselves to all coconut and rubber planters.

## DIAGRAM F.




System of drainage and silt-pits for young rubber and coconuts on hilly and undulating land.

Drain 18 in. wide by 18 in. deep, gradient 1 in 60 to 80. Feeder channel 10 in. wide by 2½ inches deep. Hole 3 ft. × 3 ft. by 2 ft. 6 in. deep filled with earth to a depth of 1 ft. 6 in. Rubber 20 to 25 feet apart and coconut 26 to 28 feet apart.

# CONTRIBUTIONS FROM THE RUBBER RESEARCH SCHEME, CEYLON.

## NOTES ON STREAKINESS IN BLANKET CREPE

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AMONG the samples of rubber which are received at the Research Scheme laboratories for examination a considerable proportion during the last few months has consisted of blanket crepe which was streaky or discoloured.

At a time of falling prices such as the present the market is always more critical than it is under more prosperous conditions, and some of the samples which were rejected by the brokers as streaky would at other times be passed as up to contract quality. Nevertheless streakiness or uneven colouring of blanket crepe is a relatively common defect, and it is not unnatural that this should be the case. Any slight discoloration or variations in colour of the lace crepe, which may hardly be perceptible when the rubber is in this form naturally become more evident when the crepe is rolled to a thick blanket. A method which the writer frequently uses for comparing the colour of two samples of crepe is to blanket the samples together and see whether streakiness results.

Information regarding common causes of streakiness in crepe is given in the recently published "Guide to the Preparation of Plantation Rubber in Ceylon" (pp. 30-32), but it is thought useful to deal rather more fully with certain causes of this defect.

*Surface Mould.*—During wet weather it is not uncommon for surface mould to develop on the lace crepe during drying. This may be so slight that it cannot be seen on the rubber with the naked eye or it may appear as small specks which are sometimes attributed to dust blowing into the factory. If the mould is severe it can usually be detected by shaking the rubber, when clouds of dust (mould spores) emerge. The presence of mould on the lace crepe will inevitably lead to streakiness or discoloration of the blanket crepe to a greater or less extent. Streakiness of blanket crepe which appears regularly during wet weather will usually be found to be caused by mould (or fungal spots).

Trouble with surface mould on crepe appears to be increasing in Ceylon factories, and it is thought that this is mainly a matter of gradual infection. Drying sheds which have been free from mould for years may gradually become infected and the trouble will then increase progressively.

Apart from raising the temperature of the drying room by artificial means, the most promising method for control of mould is the treatment of the latex with a small proportion of paranitrophenol. The amount required for complete prevention of mould in laboratory tests was found to be 1 part to 1,000 parts rubber, but it is considered that 1 part to 4,000 parts rubber is sufficient to control mould under factory conditions. Particulars of the treatment are given in the "Guide to the Preparation of Plantation Rubber in Ceylon" (p. 52), and it is emphasised there that the only disadvantage of the treatment is that crepe containing P.N.P. becomes discoloured if exposed to *direct* window light during drying. This is a serious drawback but suitable precautions to protect the crepe from direct window light can be taken without involving any appreciable expense or loss of drying space, and the method has been used in several factories during the past year with complete success. A further advantage of treatment with P.N.P. is that the blanket crepe is protected from development of surface mould or fungal spots during storage.

It is considered that mould infection in drying rooms is mainly centred on the floor, where it thrives on the serum which drips from the wet crepe, and on the reapers. In case of trouble with mould it is advisable to treat the floor-boarding with a 10 per cent. solution of "Atlas A" wood preservative which constitutes a fairly permanent disinfectant and to wash the reapers and other woodwork frequently with a 2 per cent. solution of formalin.

In the above discussion no reference has been made to the question of ventilation of the drying shed. It is taken for granted that the room must be well ventilated and that the rubber cannot dry unless there is sufficient circulation of air to remove the moisture. Mould infection may however develop even in a well ventilated drying room under the extremely humid conditions which exist in certain districts during monsoon weather and may necessitate application of the methods of disinfection detailed above.

*Light.*—It is well known that sunlight causes a brown discoloration of crepe rubber, but it is not so widely recognised that direct window light, other than sunlight, also causes discoloration. Crepe which has been dried near to windows in the drying room is always slightly off-colour and if blanketed together with the remainder of the crepe will cause streakiness. The outside rows of crepe should be taken down and rolled separately.

The discoloration is only caused by *direct* light and not by reflected light so it can be avoided by fitting shades to the drying room windows or by arranging that the crepe is hung in such a way that it is out of contact with the direct rays of light.

The method referred to is to hang the crepe to dry in the form of "mats" such as are usually prepared when crepe rubber is to be dried artificially. The mats are made by rolling the crepe on to a drum (for which a convenient size is 3 ft. wide by 1½-2 ft.

diameter) as it comes from the smooth roller. The mat contains 2-3 layers of crepe and the size and thickness is adjusted so that each mat occupies approximately the same reaper space as an equal weight of crepe hung in the usual way. When the mats are hung on the reapers the crepe is high above the floor and direct light from the windows does not fall on the rubber. Equally important is that circulation of air through the room is much improved. It might be thought that the mats would dry slowly but in practice it is found that they dry as rapidly as crepe hung in the ordinary way. This method of hanging has been in use on certain estates for a number of years, and is being adopted with success by an increasing number of estates. It is particularly useful for drying rooms with poor ventilation as it enables the air to circulate freely through the room.

*Iron in Water Supply.*—It is frequently stated that the presence of iron in the water used for diluting and coagulating latex leads to discoloration of crepe, and more especially that the rubber rapidly darkens in colour during storage. This observation may be correct under certain conditions but it has not been confirmed by tests made by the writer up to the present time.

According to a text-book on water analysis, "natural waters containing more than about 0·02 part of iron per 100,000 (*i.e.*, 1:5,000,000) usually become opalescent or turbid on exposure to the air, owing to the decomposition and oxidation of the ferrous hydrogen carbonate." This indicates the minute amount of dissolved iron which is likely to be present in water without detection, and it was considered that by preparing crepe from latex diluted with water to which iron salts had been added in proportion 1:100,000, any tendency to discoloration should be very marked.

The following samples were prepared:—

(1) Control crepe.
(2) Crepe from latex diluted with water containing ferric chloride 1:100,000.
(3) Crepe from latex diluted with water containing ferrous sulphate 1:100,000.

There was no appreciable difference in colour of the samples after preparation or after storage for five and a half months.

The other source of contamination with iron is the use of water containing suspended iron from rusty pipes. A sample of such water was obtained and the proportion of iron present found to be 1:75,000. This water was bright red in colour and must be regarded as grossly contaminated.

The following samples were prepared:—

(1) Crepe made from latex diluted with the above water.
(2) Crepe made from latex diluted with the same water after being strained through muslin.

The first sample was distinctly darker than the second (which was perfect in colour), but not more so than would be expected from the direct effect of the colouring matter present in the water. After three months' storage the sample has shown no tendency to abnormal discoloration.

In the writer's opinion the effect of iron on the colour of crepe has been exaggerated and is not likely to be serious except in the case of heavy contamination. It is possible that rapid darkening of crepe during storage which has frequently been ascribed to the effect of iron, is really due to adulteration of the latex by coolies, which is discussed in the next section.

*Adulteration of Latex.*—A case occurred recently on an estate in which crepe from one division either became streaky during drying and was discoloured when blanketed, or rapidly darkened in colour during storage. Coagulum from seven different divisions was machined and dried in one factory, and the rubber from all except one division was perfect in colour. A number of tests made by the Superintendent, such as diluting the latex with water from a different division, using fresh stocks of bisulphite and acid, carrying the latex to the main factory for coagulation, etc., were sufficient to convince the writer that the discoloration of the rubber was due to adulteration of the latex in some way by the tapping coolies (mostly Sinhalese villagers). Examination of each tapper's latex microscopically and a test for acidity showed no distinct differences, but in the case of small samples of the latex coagulated separately in aluminium cups (without bisulphite), the serum in several cups was found next morning to be pink in colour and the coagulum was discoloured. After this experiment the discoloration of the crepe ceased for several weeks and when it recurred the Superintendent checked it again by threatening to apply his test and to prosecute any tapper whose latex was found to be adulterated. At first sight the simplest course would appear to have been to secure a new gang of tappers, but it was not practicable in this case as there were no cooly lines on the division, and the Superintendent was dependent on his village tappers.

The above incident is recorded in order to show that discoloration of crepe can be caused by adulteration of the latex by tappers, and where discoloration cannot be traced to other causes this possibility should not be overlooked.

Unfortunately the writer has no information regarding the identity of the adulterant used in this case, and would be glad to hear from any Superintendent who has any suggestions on the subject.

In addition to the above causes of streakiness or discoloration of blanket crepe, there are of course the more obvious causes such as errors in treatment of the latex with sodium bisulphite, variations in the colour of the crepe from different jars of latex, failure to remove dirty edges from the crepe, etc., which are dealt with in the Handbook referred to above.

# DISEASES OF RUBBER IN CEYLON, 1929.

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1. *Introductory.*—It is thought that an article on diseases of rubber appearing in the 4th Quarterly Circular of each year will be of interest to planters. Such an article will review the general disease position in the Island during the year in question, drawing attention to any new diseases of importance and to any advances in our knowledge of the causation and control of diseases of longer standing.

2. *Root and Collar Diseases.*—As is now well known to all planters, Dr. Small has for some years maintained that the fungi commonly associated with root disease, such as *Fomes*, *Poria*, *Ustulina*, are not primary parasites, *i.e.*, are not capable of attacking unwounded healthy rubber roots. He further maintains that their attack is preceded by another fungus, *Rhizoctonia bataticola*, which is capable of attacking and killing healthy roots. This view has met with support in some quarters and opposition in others, and the comparative importance of the various fungi has not yet been determined. Most mycologists now consider that *Rhizoctonia* is parasitic on Hevea and can cause its death under certain conditions, but that it has not yet been proved to be a necessary precursor to attacks by the other fungi.

In the meantime it is important that the usual methods of root disease treatment be rigorously carried out. This is particularly important at the present time in view of the heavy cover of Vigna on some estates. Many estates in the wetter districts which have had a thick ground cover established for some years are now finding a considerable incidence of *Fomes lignosus* root disease. In every case observed by the writer the outbreak has occurred in the vicinity of old disease areas and can be traced to incomplete treatment in the past. Owing to the presence of a thick cover of Vigna the disease has often spread over a considerable area before it is discovered. It cannot be too strongly emphasized that in treating such areas the limits of the disease on all sides must be found before the isolation trench is dug. The ground within the trench must be thoroughly cleared of all roots down to about the size of a lead pencil, and the roots and Vigna burned *in situ*. This is the only method of insuring that the disease area will not prove a source of infection to neighbouring trees in the future. In addition, an area treated in this way may safely be replanted in a comparatively short time.

Although a thick cover assists the spread of root disease in several ways, it would be a mistake for an estate to deny itself the undoubted advantages to be derived from cover crops because of the possible danger of root disease. The only limitation to be placed on the growth of cover crops is that they should not be grown on areas known to be affected.

In low-country districts *Ustulina zonata* is responsible for more deaths than any other fungus. Some estates have adopted the filling method of treating collar rot advocated in the Rubber Research Scheme 4th Quarterly Circular for 1925, but this can only be successfully carried into operation if the disease is detected at an early stage. In order to render the detection of this disease easier, any ground cover should be kept clear in a circle, about 6ft. in diameter, round the base of the tree. Where *Ustulina* fructifications are present it is a sound practice to paint them over with tar or disinfectant before the branch or trunk is cut. This is particularly important on young fructifications as these bear spores on the surface which are easily blown about and may cause fresh infection.

Other root fungi are of minor importance. Instances of Brown Root (*Fomes lamaoensis*) and *Sphaerostilbe repens* have been reported but these fungi are rarely of serious consequence. *Xylaria furcata* was found on two occasions in circumstances suggesting that it may have caused disease.

In general the position as regards root disease in the Island may be considered satisfactory. Root disease is almost entirely absent from the drier mid-country districts, while in the low-country, although *Fomes lignosus* and *Ustulina* are of wide occurrence, there are comparatively few estates on which large areas are affected. The methods of preventing the spread of root disease show considerable improvement; less reliance is being placed on trenching alone and more attention is being given to the eradication of all diseased roots from an affected area.

3. *Stem Diseases.*—(a) *Bark Rot* continues to cause damage in certain districts but may be almost completely prevented by careful disinfectant painting. Some estates which use Cargilineum Mixture only have suffered from this disease owing to being unable to apply the mixture on trees which have remained almost continuously wet for some days. All estates should have a water-soluble disinfectant in readiness for application under such conditions. (b) *Canker* is prevalent on many estates in the wet districts but is not considered to do much harm except where the actual tapping surfaces are affected. (c) *Brown Bast* is prevalent in the dry districts of Matale and Uva and must be considered as the most serious factor adversely affecting yields in these districts. On some estates the disease is being treated by the scraping and isolation method recommended by the Rubber Research Scheme (R.R.S. Bulletin No. 48), and

in this way many trees are being brought into tapping. It is hoped that if the price of rubber rises, further work of this nature will be done. On one estate in the Kalutara district a rot of recently scraped panels developed despite the application of disinfectants and considerable damage was done.

4. *Leaf Diseases.*—Secondary leaf-fall due to *Phytophthora palmivora* (*P. Faberi*) was more severe in some districts than in 1928, but its occurrence in Ceylon is not sufficiently severe to cause alarm. It is probable that cultivation and manuring will lessen the effects of this disease.

*Oidium* leaf disease has been the subject of special investigation by the Rubber Research Scheme and an article on the subject was written in the 2nd Quarterly Circular for 1929. The disease is widespread in all the rubber-growing areas but has not caused any serious defoliation in the main low-country districts. In the dry districts of Uva and Matale, however, the disease is extremely severe and many estates have suffered considerable defoliation. Although no decreases in yield are yet evident as the result of *Oidium*, such a disease which causes severe defoliation and consequent die-back of branches must be regarded as extremely serious, and an effective means of control is urgently needed.

It is probable that applications of nitrogeneous manure will ameliorate the worst effects of the disease. Such a method, however, exercises no direct control over the fungus and the best hope of eradicating the disease lies in dusting with sulphur powder. In Java, where *Oidium* leaf disease has been present since 1918, extremely successful results have recently been obtained by projecting finely-divided sulphur powder on to the foliage by means of a motor duster. The method is quick and cheap compared with wet spraying and will probably solve the problem of *Oidium* control. Special interest is therefore attached to dusting experiments to be conducted in Ceylon early in 1930.

5. *Diseases and Pests in Nurseries.*—The recent increase in the use of valuable bud-grafted material has drawn attention to the various affections to which young shoots are prone.

In the R.R.S. 3rd Quarterly Circular for 1929 attention was drawn to a new disease of bud-shoots caused by *Phytophthora* sp. The green shoot is attacked a few inches below the extremity and dies back rapidly to the extent of the latest growth increment where the disease may be checked. The disease has not been reported from any estate on a large scale and is probably to a great extent dependent on wet weather conditions. Inoculation experiments have shown that seedlings may also be attacked by the fungus, though the disease has only been reported as occurring in nature on bud-grafts.

If the disease appears in the nursery or the field all affected shoots should be cut off about 6 inches below the margin of the discoloured area and neighbouring shoots sprayed with Bordeaux Mixture.

There are several other adverse factors which check the growth of young budded plants. *Mites* cause damage to young leaves and are most effectively controlled by dusting with sulphur powder or spraying with *Sulfinette*. *Slugs* are often found to eat off the terminal shoot, and damage to leaves has also been attributed to *beetles*. In addition it is probable that the dying back of young rootlets consequent upon cutting back the stock often finds its reflection in a check in growth of the bud-shoot.

6. *Cover Crops*.—The Kalutara snail is still causing considerable damage to Vigna in some districts, and no infallible method of control has yet been devised. The "lime-Atlas" treatment for poisoning the snails recommended by Mr. Roy Bertrand in *The Tropical Agriculturist* for September 1928 has been found successful on some estates, though other Superintendents have had no appreciable results. Hand collecting and destroying the snails is still considered to be the most effective remedy.

Vigna is commonly attacked by two fungi, though in neither case is the disease of a serious nature. *Rhizoctonia solani* kills back the Vigna in small circular patches in wet weather, but these soon recover in a dry spell. A brown spotting of Vigna leaves has been shown to be due to *Uromyces* sp., a rust fungus. The leaflets turn yellow and fall and in very dry weather the cover may be killed back.

# THE EELWORM-GALL OR ROOT-KNOT DISEASE *

## (CAUSED BY CACONEMA RADICICOLA (GREEF) COBB, FORMERLY KNOWN AS HETERODERA RADICICOLA (GREEF) MULLER).

[Note.—The cosmopolitan eelworm *Caconema radicicola* is well known in Ceylon. It is particularly troublesome in flower beds, vegetable gardens and estate nurseries. The plate reproduced herewith shows tea seedlings from a nursery with typical root-knots or galls caused by the eelworm. Useful notes on methods of control are given in the article printed below.]

ALTHOUGH apparently unknown in the south-western portions of this State, *Caconema radicicola,* the organism responsible for the development of eelworm-galls or root-knots on the underground portions of many of our cultivated plants, is widely distributed in the metropolitan zone around Perth, and has recently attracted considerable attention in the light sandy soils of the Geraldton area.

The eelworms in question are very small round worms, somewhat less than 1/25th in. in length, which may attack the underground parts and form galls on almost all our cultivated species with the exception of most grasses and cereals (wheat, oats, barley, rye, maize, etc.) and a limited number of other plants.

In Western Australia the worms have been found forming galls on the roots or other underground parts of potatoes, tomatoes, cape-gooseberries, marrows, pumpkins, melons, cucumbers, carrots, parsnips, beetroot, beans, mangolds, tobacco, rhubarb, grapes, figs, banana, dahlia, boronia, ceinfugosia hakeifolia, wattles, and many other plants of an edible, flowering, or ornamental nature. Cauliflowers, cabbages, peas, asparagus, artichoke, spinach, onions, and sweet potatoes are not usually attacked to such an extent as the other market-garden plants previously mentioned. Considerable differences in varietal susceptibility occur in almost all plant species attacked. The eelworms are rarely, if ever, found in heavy clay soils, but thrive abundantly in loose, well-drained, sandy soils in warm districts or situations. It is on this account that eelworms have so successfully established themselves in the Perth districts and environs. The disease is very serious in many parts of the world where flowers or vegetable are grown under glass, and under such circumstances periodic sterilisation of the soil by means of steam is commonly practised to rid the soil of the pest. Unfortunately this method is at present quite impracticable in Western Australia.

*Symptoms and Effects.*—Plants badly affected are dwarfed, wilt readily in hot weather, and are usually a paler green than healthy ones. Seedlings and even older plants may be killed in quick time if severely attacked, or great reduction in yield may result. Sometimes, however, little damage or reduction in yield is apparent, especially if abundance of water, fertiliser and organic matter can be supplied to the plants. In this connection

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* By H. A. Pittman, B.Sc. Agr. in *The Journal of the Department of Agriculture, Western Australia,* Vol. 6 (Second Series) No. 3, September, 1929.

it is very well worthy of note that any means which tend to reduce the proportion of top-growth to rooting system (such as pruning out of excess lateral shoots in tomatoes and the copious use of superphosphate and sulphate of potash) will tend to reduce the injury done by the worms.

On being pulled up infected plants will be found to show more or less numerous warts or swellings of the roots or other underground-parts. Potatoes are usually attacked on the tubers, but the organisms may also invade the roots and underground stems. Infected potato tubers show many or few, more or less scattered, flat-topped pimples or blisters on the surface, often about one-eighth inch in diameter and elevated about the same distance above the general level of the healthy tissues. The lesions may be much larger, however, in certain cases, and where attack is bad may be very close together, giving a much distorted appearance to the affected parts. Sometimes numbers of the blisters will be found to be broken open or decayed as a result of subsequent attack by fungi or bacteria. If infected potatoes are cut open, small brown areas will be seen in the flesh under the pimples and extending to a depth of about ¼ in. in some cases. It is in these brown areas that the eelworms occur, but on account of their very small size the males and young are not readily seen without a strong lens or microscope. The mature egg-filled females, however, are much broader than the other stages, being pear-shaped and about 1/25th inch in diameter, and they can sometimes be distinguished with the naked eye as glistening pearly-white bodies within the discoloured tissues. Eelworms are often introduced into clean land in potato peelings, and this may be considered one of the main means of dissemination by unsuspecting persons. The use of the manure of animals fed on infected plants also leads to the distribution of worms, as they are not all destroyed by passing through the intestines.

Carrots, parsnips and other fleshy-rooted plants may show large warts which greatly disfigure the appearance of the edible portions. On plants with more slender underground parts, the galls or warts may somewhat resemble the bacterial nodules which are so necessary a feature on the roots of plants belonging to the pea or bean family (*Leguminosæ*). Even on such plants, ho ever, the experienced eye soon learns to detect the eelworm-galls if present in addition to the bacterial nodules. The eelworm-galls on these plants are often very close to the root tips—they are mostly much more enlongated, cylindrical and narrow than the bacterial nodules, and the follow the length of the roots or rootlets rather than jut out as large swellings to the side, as do the nodules due to the bacteria. They are, in short, on leguminous plants generally longitudinal swellings of the root rather than more or less knobby lateral outgrowths. Plants of the cabbage family (*Cruciferæ*) are sometimes attacked on the roots by the Club-root organism—*Plasmodiophora brassicæ*—but the swellings in such a case are enormously larger and are easily distinguishable from eelworm-galls.

*Life History.*—The young eelworms or "larvæ" which hatch out of the eggs laid in the old galls eventually puncture the roots of the host plant by means of spear-like structures in the mouth parts called buccal-spears, and enter into tissues of the root or similar part just behind the growing points. By their presence the root or tuber, etc., is stimulated to unusual activity and the characteristic galls result. On attaining full size the male and female eelworms mate, and subsequently the female becomes greatly distended and may produce as many as five hundred eggs. In loose, warm, moist soils, up to twelve generations may be produced in a year, as the life cycle can, under such circumstances, be completed in four to five weeks. The "larvæ" and adult males are elongated and like miniature earth-worms in shape, but the fertilized females are pear-shaped on account of the body being distended with eggs.

*Susceptible Plants.*—For general information the following list of the most important susceptible plants is taken from Heald's "Manual of Plant Diseases."

1. Field crops. Alfalfa (lucerne), clover, cotton, cowpea (most varieties), sugar beet, sugar-cane, sweet potato, tobacco, and vetch.

2. Ornamental and drug plants. Begonia, Cineraria, Clematis, Coleus, dahlia, hollyhock, ginseng, Golden seal, peony, rose, sweet pea, and violet.

3. Truck crops. Asparagus, bean, beet, carrot, celery, cucumber, dasheen, eggplant, garden pea, lettuce, okra, onion, pepper, potato, rock-melon, salsiffy, spinach, strawberry, tomato, and water melon.

4. Woody plants. Almond, catalpa, cherry, date palm, European elm, mulberry, grape, peach, pecan, walnut, and weeping willow.

*Resistant Plants.*—Nearly all grasses; cereals such as wheat, barley, oats, rye, maize, and sorghum; "Iron," "Brabham," "Monetta," and "Victor" cowpeas; peanut; "Laredo" soy bean; velvet bean.

## CONTROL.

1. Farmers or householders should be very careful never to plant potato tubers or seedlings of any kind showing eelworm-galls. If your farm or home garden is free at present, do all you can to keep it free. This means, among other things, raising your own seedlings and boiling the peelings of any potato tubers used for household purposes which appear to be infested with eelworms. It is very likely that the eelworms have been chiefly carried about the State in potato tubers and introduced into the gardens and fields in the potato peelings. The true seeds of plants as distinct from tubers, bulbs, etc., do not carry the eelworms.

2. (a) In seedbeds the eelworms can be destroyed by treating the soil with carbon-bisulphide at the rate of $1\frac{1}{2}$-2 oz. per square yard before sowing the seed. Make four evenly-spaced holes 8 inches deep to every square yard of soil with a round stick. Into each pour, per medium of a funnel, approximately $\frac{1}{2}$-$\frac{1}{4}$ fluid ounce of the carbon-bisulphide and quickly cover with moist earth. Cover the seedbed with clean bags and leave for several days. Then aerate thoroughly by turning over several times and leaving to stand for several days before planting the seed.

(b) Where carnations, dahlias and other flowering or ornamental plants in gardens are found to be attacked, the eelworms can be largely killed by treating the soil with one fluid ounce carbon-bisulphide to the square yard in evenly-spaced holes not closer than 9 inches to the base of the plants. After pouring the required amount down each hole (about $\frac{1}{4}$ ounce), close the hole with moist earth. The fumes will spread through the soil and kill many of the eelworms in the soil and roots. Both the above-mentioned treatments have been tested out over a considerable period of years by Mr. L. J. Newman, Economic Entomologist of this Department, with satisfactory results. Do not water the soil for several days after treating or the carbon-bisulphide may be forced out of the soil. *Above all, remember that carbon-bisulphide is exceedingly inflammable and explosive in the presence of a spark, lighted cigarette or flame. The fumes are also poisonous if inhaled for any length of time, so that the fumigant must be handled with all due discretion.*

(c) Experience in America and other countries indicates that formalin may be used fairly satisfactorily for treating eelworms in seedbeds. The formula now being mostly recommended is 1 gallon of formalin to 50 gallons of water (*i.e.*, a so-called 2 per cent. solution). The solution is applied with a watering-can to the soil, which should previously have been well loosened

up, at the rate of about ½-1½ gallons of the solution to the square foot (1). Cover the soil with bags moistened with the solution and leave for several days. Then remove the bags and stir the soil up thoroughly to let out the fumes. Leave for 10 days or a fortnight before sowing. This treatment is exceptionally efficient for destroying such soil fungi as cause "damping-off" and "root-rot" and it also appears to give fairly good results with eelworms. Be careful, however, not to re-contaminate the soil by using dirty implements from infested ground, or by walking over the beds with contaminated boots, etc.

(d) Eelworms can be killed out by suffocation, if the soil in the seed-beds or field can be kept flooded with water for 3-4 weeks. In such a case, however, the soil must, of course be freed of excess of water and well aerated before sowing the seeds or planting out.

(e) In many countries steam-sterilization is used to free the soil in glass houses from eelworms, with extremely effective results, but the method is impracticable here.

(f) J. R. Watson (2) of the Agricultural Experiment Station, University of Florida, who has given considerable attention to the control of treatment for seedbeds from which the following details have been worked out (3). First of all, dig over the seed-beds thoroughly, then water with sodium cyanide solution at the rate of three ounces of the solid cyanide to each square yard of soil. Add further water until the soil is moistened to a depth of 18 inches throughout. Then immediately afterwards sprinkle four and a half ounces (4½ oz.) of sulphate of ammonia over each square yard and water in with just sufficient water to carry the sulphate down. The two chemicals react with one another, forming sodium sulphate, ammonia, and hydrocyanic acid gas (prussic acid), which kills the eelworms. Watson (*loc. cit.*) states: "If nematodes (eelworms) appear at all in such seedbeds, they will be in isolated spots which can be rejected at planting time. If, on the other hand, the desire is for plants which can be depended upon to be absolutely free, as for setting in uninfested ground, application of at least 1,200 lb. cyanide (of sodium) and 1,800 lb. ammonium sulphate to the acre should be applied," *i.e.*, about 4 ounces of the cyanide and 6 ounces of the sulphate of ammonia to each square yard.

Cyanide of potassium can be used instead of cyanide of sodium, and from the point of view of subsequent soil fertility, would appear to be considerably superior to the sodium compound. It has the disadvantage of greater cost, however, and, in addition, one must use one-third more of the potassium cyanide to each square yard, *i.e.*, 4 ounces, instead of 3 ounces of the sodium cyanide. The amount of sulphate of ammonia is, however, the same in each case. If the above method is used for sterilizing seedbeds, *great care must be exercised in handling the cyanide as it is one of the most deadly poisonous substances known to science. In the case of poisoning, immediately give a weak solution of green sulphate of iron (ferrous sulphate or "green vitriol") as a drink, and then empty the stomach by means of a stomach tube or by inducing vomiting with a mustard emetic. Send post haste for medical assistance. Above all do not use the cyanide method unless you have a supply of the antidote ready in case of need and have carefully instructed all the persons concerned in its use. The poison is so powerful and rapid in its action that unless treatment is immediate there is very little hope.*

3. On a field scale every encouragement should be given to the plants in the way of water, organic matter, and fertiliser to enable them to stand up to attack. Tomatoes should be pruned to a single stem and tied up to stakes. The reduction in the excessive top-growth may then make it possible to obtain fairly heavy yields even though the roots are rather badly attacked.

Tea seedlings showing galls caused by the eelworm *Caconema radicicola.*

4. Where the soil in the field is badly contaminated with the pest, well-worked summer fallow should be practised, as in such a case the drying out of the soil kills great numbers of the parasites. The following season a resistant crop (such as wheat or oats, etc.) should be sown, and then the susceptible crop can be sown with little fear the next season. This means that on badly infested tomato fields, for instance, the tomatoes should only be grown on the same land every third season. A division of the cultivated land into three more or less equal parts therefore seems imperative when the eelworms become firmly established. This means, of course, that the smaller area must be very intensively worked while it is in crop, but each year a comparatively clean area would be available for the main money-making plants. All weeds liable to harbour the worms should be prevented from growing along the headlands and ditches, etc.

5. Experiments recently reported by Edwards (4) in England indicate that good results might be obtained on a field scale by ploughing-in crude naphthalene to a depth of 6 inches, at the rate of eight hundredweights (8 cwt.) to the acre, followed by rolling, about a fortnight or so before planting. In the experiments referred to, very striking results were obtained in the treatment of a "potato-sick" soil where there was a very heavy mixed infestation of the soil with another species of eelworm, *Heterodera schaactii,* and the fungus *Rhizoctonia solani.* The material actually used was "drained creosote salts" (stated to be a crude form of naphthalene), selling in England for about 10s. per cwt. Experiments by the Department are projected to test the actual efficacy of the treatment for the local eelworm, *Caconema* (*Heterodera*) *radicicola.*

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# AGRICULTURAL METEOROLOGY IN ITS PLANT PHYSIOLOGICAL RELATIONSHIPS *

AGRICULTURAL meteorology is the study of the effects of meteorological conditions on plant yield. Yield, with which the practical man is alone concerned, is of course, the final expression of the integration of the whole complex of physiological processes of the plant. One is dealing with a very complex system in which the physiological processes of the plant react with the external conditions. Meteorological conditions such as temperature, light intensity, humidity of the air, since they produce a marked effect on the rate of important physiological processes in the plant, are often termed "factors"; we speak of the growth of a plant, being controlled by a temperature factor, a light factor and so on. These meteorological factors for the most part vary continually during the growth of the crop, which may last over many months or even years.

One of the central problems of plant physiology is the elucidation of the effect on the plant of the external factors of the environment and of these the meteorological factors are not the least important. The problem is one of great difficulty. In the first place a living organism is an exceedingly complex system and one which is highly integrated. The various processes on which the life of the organism depends are very closely coordinated and, indeed are necessarily so if its life is to continue. It follows that a change in one process in the plant may markedly affect the rate of other processes; thus it is hard to distinguish between primary and secondary effects.

There is in addition a second complication which shows itself even in the study of a single physiological process. This complication is the high "interrelationship" of the factors affecting such a process. The effect produced by any one factor is markedly dependent on the intensity of other external factors. Thus, if we are considering the effect of the sun's radiation on the rate of sugar formation in the leaf we find that the effect produced varies with the temperature of the leaf and the concentration of carbon dioxide available. If the temperature is low a doubling of the light intensity will have only a slight effect, while with a higher temperature the effect will be greatly enhanced. The close interrelationship of factors is one of the chief lessons of more recent physiological work, but one which makes much more intricate the study of the effect of meteorological conditions on plant processes such as growth.

In the third place the variation of the environmental factors—especially the climatic factors—from day to day, from hour to hour and even from minute to minute, adds another difficulty to the interpretation of crop yield in terms of the effect of such factors on the physiological processes of the plant.

It must also be pointed out that there is often a considerable lag in the action of a climatic factor and the appearance of the resultant change in the plant. Crop yield may be largely determined by a bright period or a period of rainfall which occurred long before; we have a process known as physiological predetermination.

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* Paper read by V. H. Blackman, Sc.D., F.R.S., (Research Institute of Plant Physiology, Imperial College of Science and Technology) before the Agricultural Section of the Conference of Empire Meteorologists, 1929.

As has already been stated, the contribution which plant physiology can make to agricultural meteorology consists in analyses of the way in which climatic factors affect crop yield. This analytical problem can be attacked in three ways. In the first place the plants may be studied under *field* conditions, various physiological processes, such as rate of increase of dry weight, rate of increase of leaf area, rate of assimilation and respiration being followed *throughout the growing season.* Work of this kind is very laborious and, owing to the large variation of plants grown under field conditions large samples have to be collected to obtain significant results. A full field experiment of this kind has not yet been carried out.

In the second way the experimental technique is simplified by growing the plants in pot-culture in the open. The plants are thus exposed to natural climatic conditions and the correlation of their various physiological processes with climatic factors can thus be determined. The most elaborate study of this kind is that of F. G. Gregory referred to below.

The third mode of attack is a study in the laboratory of the effect of various climatic factors such as temperature, light, humidity, on the growth and other processes of various plants or plant organs. Useful knowledge may be obtained in this way, but owing to the interrelationship of factors referred to earlier and the high integration of the plant body it is difficult from a study of the effect of a single factor on single organs to deduce the action of a complex of meteorological factors upon the plant as a whole.

## CORRELATION BETWEEN THE INTENSITY OF CLIMATIC FACTORS AND THE GROWTH OF PLANTS.

The only elaborate investigation that has been made of this relationship is the study of barley by Gregory in the years 1921-1924 (*Annals of Botany,* XL, 1-26, 1926). As already stated, the plants were grown in pot-culture, the water-content of the soil being kept up to a lower limit by artificial supplies though this limit was exceeded in periods of rainfall. Seven environmental factors were recorded during the experimental periods of each of the four years namely, maximum day temperature, average day temperature, minimum night temperature, average night temperature, total radiation (calories per cm.$^2$ per week), hours of bright sunshine, and evaporating power of the air. Three physiological processes of the plant were measured, namely, net assimilation rate, relative rate of growth of leaf surface, and relative rate of increase of dry weight. Owing to the high correlation of the external factors (solar radiation and temperature, for example, tend to vary together) partial correlations had to be determined. It was shown that the net assimilation rate had a high partial correlation with day temperature and with radiation, and this was *positive,* while there was high *negative* correlation with night temperature. This last result is to be explained by the fact that a high night temperature pushes up the rate of respiratory loss and so reduces the rate of net assimilation.

A partial positive correlation of relative leaf growth with average day temperature was observed and a negative correlation with night temperature, and also a large negative correlation with total radiation. The fact that the correlation with total radiation is positive for net assimilation but negative for relative leaf growth rate tends to keep the yield constant. High radiation will tend to reduce the rate of leaf-area growth but compensation will occur since the high radiation will increase the assimilatory efficiency of each unit of leaf-area.

It is clear from the few results that have been quoted that the method employed by Gregory is a very fruitful one. Much light could be thrown on agricultural meteorology by an extension of this method. By growing one or more crop plants in exactly similar pot-cultures in localities with

widely different meteorological environments and determining by the method of correlation the reaction of the plants to the various climatic factors very valuable knowledge would be obtained.

In the third method of attack on the physiological problems of agricultural meteorology the effect of the various climatic factors on the plant processes is investigated. It will be useful then to give a brief survey of the action of these factors on the plant.

## EFFECT OF TEMPERATURE.

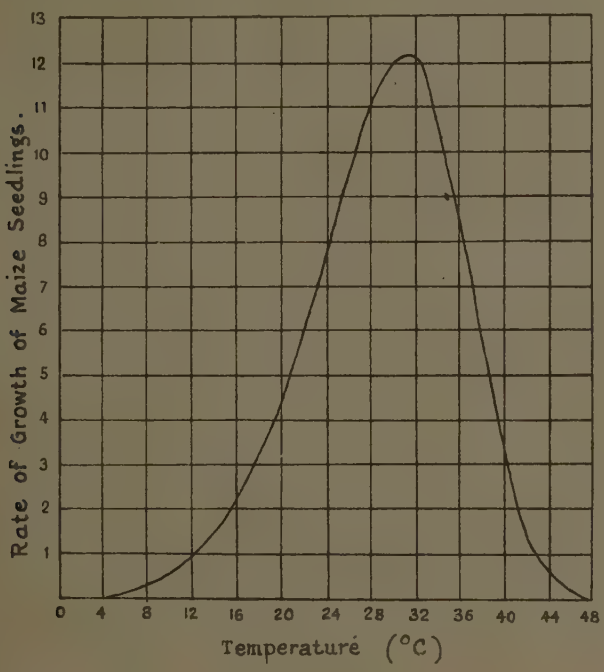
The question of how to summate temperatures so as to relate them most satisfactorily to their effect on plants has been a burning one in plant geography for a very long time and a similar problem arises in relation to plant physiology. De Candolle as long ago as 1874 divided the earth into temperature zones, the lowest having the temperature of most months below 0° C., and the vegetative period for plants between 0° and 5° C.; the other zones had mean temperatures of 0 – 14°, and 15° – 20° and the zone of highest temperature about 25° C. A great flaw in the system of De Candolle was the complete neglect of yearly periodicity which plays such an important part in the life of plants in temperate regions. Koppen improved on the system of De Candolle by defining the cold zones as those with one to four months with a temperature over 10° C., and later he related his zones to the position of the isotherm 18°C., during the coldest months and the isotherm 22° C. for the warmest months.

It is obvious, however, that in addition to the length of the period of growth the duration of high and low temperatures must be considered. Some authors accordingly summate in temperature hours over the whole year or for the frost-free period. Livingstone and Shreve (*Publ. Carnegie Institution, Washington,* No. 284, 1921) take into account the number of frost-free days during the vegetative period and summate the temperatures in these and determine also the number of days with a temperature over a definite level. Vahl takes the mean temperature of the coldest month and the mean temperature of the warmest month and from them constructs a formula, as does also Samuelsson. With such formulæ they have been able to correlate with temperature the northern limits of wheat in Europe and Siberia, and also the distribution of the hazel.

Though some slight success may be obtained in this way in correlating temperature with the distribution of some plants, it is evident that a formal treatment of this kind is doomed to failure when a living organism such as the plant is in question. If we wish to determine the activities of the plant in terms of temperature, it is evident that we must use physiological data which embody the response of the plant to such a meteorological factor. Livingstone and Shreve (*loc. cit.*) were the first to attempt to use physiological data in climatological work. They weighted their temperature averages according to the growth rates of plant organs which had been observed at different temperatures under laboratory conditions. This method, however, had not much success in determining plant distribution and this is not very surprising. Growth data of this kind are not available for many plants and they refer usually to particular parts of the plant such as the root and not to the plant as a whole. Apart from this, however, there is the strong objection to the method itself that it uses physiological data which relate temperature merely to the *growth* of the plant. There are, however, other processes in the plant, such as assimilation and respiration, which are of equal or greater importance for its development, but unfortunately these may have a markedly different response to temperature than the mere elongation of the plant which is usually considered as growth. The evident need is for temperature curves of all three processes of assimilation, respiration and growth so that the effect of temperature on the plant

as a whole can be accurately determined, though there must, of course, be other processes in the plant whose response to temperature is different from that of any of the three processes just mentioned.

How different are the responses of growth, assimilation and respiration is shown by the graph below which gives the relationship between temperature and rate of growth in length of the shoots of maize seedlings, and table I, after Lundegärdh (*Biochem. Zeit.* 154, 213, 1924), which indicates the effect of temperature on the rate of the processes of respiration and assimilation of the leaves of the potato plant.




## Table I.

*Effect on Rate of Assimilation and Respiration of Raising Temperature* 1° C.

| Temperature | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 49° |
|---|---|---|---|---|---|---|---|---|---|---|
| Respiration | 1·08 | 1·08 | 1·06 | 1·10 | 1·07 | 1·07 | 1·06 | 1·29 | 1·01 | 1·46 |
| Assimilation— | | | | | | | | | | |
| With full light | 1·27 | 1·25 | 1·08 | 1·08 | 0·96 | 0·92 | 0·81 | — | — | — |
| With 1/25 light | 1·18 | 0·95 | 0·90 | 1·52 | 0·79 | 1·00 | — | — | — | — |

Such a graph and such table show how futile is a mere summation of temperatures, for the effect of a given rise of temperature may be very different at different temperature levels. Thus, at 5°C. an increase of temperature of 1° increases assimilation (at high light intensity) by 27 per cent., while a similar rise at 15° C. increases the rate of the process by only 8 per cent. The table also shows that assimilation and respiration respond differently

to variations of temperature. It is of course only the *excess* of material formed in assimilation over that lost by respiration that is available for the growth and development of the plant. At higher temperatures the amount lost by the respiration of the plant may be in excess of that gained by assimilation. How large respiration losses may be is shown in Table II, also from Lundegärdh, showing the *hourly* loss by respiration during the night from 1 hectare of a potato field.

Table II.

*Potato Field.*

*Respiration Losses per Hour per hectare.*

| Temperature | 0° | 5° | 10° | 15° | 20° | 25°C. |
|---|---|---|---|---|---|---|
| Losses (kilograms) | 0·45 | 1·0 | 1·5 | 2·0 | 3·0 | 4·5 |

Since respiration means a loss to the plant and assimilation a gain, a fall of temperature at night may be advantageous to the plant while the same condition during the day would lead to a fall in assimilation and so a loss to the plant. A calculation of Lundegärdh's of the assimilation and respiration per hectare of an oat field at two *night* temperatures is given below (Table III).

The facts that assimilation and respiration are affected differently by a temperature rise; that a temperature rise may act favourably by day and unfavourably by night; that the relationship is linear in neither case; and that the process of growth shows a different response to *either* of these, indicate the complexity of the problem of the plant's response to temperature and proves of how little value are temperature summations.

Furthermore, there is the additional complexity which has been referred to earlier, namely the interrelationship of factors. The temperature effect is markedly altered by the intensity of the other factors. As Table I shows, the effect on assimilation of a rise of temperature is in general less (as would be expected) when assimilation is kept low by a feeble light intensity than under conditions of high illumination. A fall of temperature of 10° C. at night may thus increase by 30 per cent. the total material available for the plant in that period, as Table III shows.

Table III.

*Oat Field.*

*Assimilation and Respiration per hectare.*

| *Assimilation.* | *Respiraton.* | *Gain.* |
|---|---|---|
| 300 kg. | 175 kg. (20° C.) | 125 kg. (300-175) |
| 300 kg. | 132 kg. (10° C.) | 168 kg. (300-132) |

With reference to the effect of temperature on crop yield the meteorological data of air temperatures are probably as accurate and as complete as can be desired. The plant physiologist, however, can only make full use of them when more physiological data are available as to effect of temperature and change of temperature on various plant processes, such as assimilation, respiration, growth, flower production, etc.

From the agricultural point of view the temperature of the air is of high importance, but that of the soil, which controls the temperature of the underground portions of the plant, is probably of equal importance. It is unfortunate, therefore, that data of soil temperature are not usually available.

## EFFECT OF LIGHT: QUALITY AND INTENSITY.

Plants are sensitive both to total intensity of light and to its quality. For some processes, such as assimilation, the less refrangible portion of the spectrum is the more important; for others, as the process of elongation, the more refrangible rays have the greater effect. Plant growth and crop yield are thus the result of the integrated effect on the plant of light of varying intensity and quality. The minimum intensities of daylight under which plants can live is, of course, variable for different species, but is remarkably low. Thus, Shirley (*Amer. Journ. Bot.*, XVI, 354-390, 1929) has shown that many plants will grow under illumination from gas-filled electric lamps of an intensity less than 40-foot candles and buckwheat will grow at 25-foot candles. Sunflower is much more exacting, requiring considerably higher intensities. An interesting compensation effect was found by this observer, for the lower the light intensity the greater the chlorophyll content of the leaves. The response varied in different plants, but the increase in chlorophyll content was never as great relatively as the fall in light intensity. In the hog peanut (*Amiphicarpa monoica,*) which showed the largest response, the concentrations of chlorophyll were 3·1 and 1·2 mg., respectively, per 100 cm.$^2$ for light intensities of 1 per cent. and 71 per cent. of full daylight.

It must be pointed out that though "hours of bright sunshine" are well correlated with "total radiation" (as measured, for instance, by the Callendar Recorder), yet the mere duration of sunshine without any measure of its intensity is very unsatisfactory for plant physiological work. A record of total radiation is certainly an advance over hours of sunshine, but, since it is the luminous rays that are important in plant processes, a measure of changes of brightness throughout the day would be the most valuable.

The effect on plants of light of different quality is still a field in which we have little knowledge, though it is certainly of great importance. It is known, as stated above, that the red orange rays are the more important in the assimilation of plants and the blue end of the spectrum in growth and movement. Plants can, however, be grown in considerable ranges of spectral quality, as is shown by the fact that healthy growth may be obtained both in daylight and under electric lamps. The effect on the plant of the change in spectral quality of daylight which occurs on the transition from an unclouded to a cloudy sky, and also with the diurnal variation from sunrise to sunset, is still unknown. With greater knowledge of the biological effect of light of different wave length plant physiologists will no longer be content with a record of total light intensity but will require for work in agricultural meteorology a record of the spectral quality of light in different localities and also a continuous record of the diurnal variation of this quality.

## EFFECT OF HUMIDITY OF THE AIR.

The humidity of the air is one of the dominant factors in plant growth and crop yield. Its effect is, of course, largely dependent on the soil moisture available to the plant. The loss of water from the plant, if other conditions remain the same, is directly related to the evaporating power of the air. It is perhaps unfortunate that meteorological records of humidity are usually given in terms of *percentage saturation* of the air, since such data are only comparable among themselves if the temperature is constant. Thus, air having a 70 per cent. saturation at 20°C. and 30°C., respectively, has very unequal evaporating power, for the saturation deficits are 5·22 mm. and 9·47 mm. of mercury in the two cases. From the agricultural standpoint what is required is the "saturation deficit" of the air, for on this depends the water loss from the plant.

## PHOTOPERIODISM.

Reference must be made to the more recent work of Garner and Allard in America, who have shown that a hitherto unsuspected meteorological condition—namely, length of day—has a marked effect on flower development, and so on crop yield. It is a familiar fact that many plants flower only at certain seasons of the year, such as spring and autumn. It was usually assumed that temperature was the dominant factor, the appearance of spring flowers being associated with the warmth that follows the chill of winter, while autumn flowering seemed to be the result of the decline of temperature as we pass from summer towards winter. Though temperature is certainly a very important factor it is not the dominant one in relation to flowering. One cannot make the iris flower in winter by putting it in a greenhouse, or asters and chrysanthemums flower in summer by lowering the temperature. It is clear that with many plants the time of flowering and fruiting is linked with the season. The clue to the nature of this relationship was gained from a study of a valuable variety of tobacco, Maryland Mammoth, grown in the United States. This plant when growing in Virginia produces no seed but goes on growing steadily during the season, reaching a height of even 12 ft., till finally it is cut down by frost without flowering. A plant, however, which was placed in a greenhouse in autumn flowered in a short time and set seed. It was at first thought that the effect was one of temperature, but it was soon found that whatever the conditions the plant would never flower in the summer but only in the winter. The time of flowering was shown to be controlled by *length of day*, the tobacco in question being a "short-day" plant which would not flower in the long days of summer. It was later shown that many other plants showed the same characteristic and *could be induced to flower in summer by artificial shortening of the period of exposure to daylight.* The term *photoperiodism* has been applied to this phenomenon, and it is certainly a very striking response of the plant to meteorological conditions. The nature of the action is still obscure, but it would seem evident that the photochemical effects on the plant alter with the duration of exposure, even if the intensity is kept constant.

## CONCLUSION.

The general conclusion may be drawn that the ordinary meteorological data of temperature and humidity are adequate for plant physiological purposes, though soil temperatures as well as air temperatures are required for the fuller study of the plant's reaction to this climatic factor. With regard to light, what is required is a measure of total radiation or, what would be still better some measure of brightness and its variation during the day. The plant is certainly affected by light quality as well as light intensity, so that as our knowledge increases there will be need for a record at different localities of the energy distribution throughtout the spectrum and its changes during the day.

# RUBBER IN BORNEO *

## METHODS OF PROPAGATION AND PLANTING

BUDDING was much discussed during the year owing to favourable reports from the Dutch East Indies, but on only a few estates was work actually carried out. More would doubtless have been done if it had been easy to obtain bud-wood from trees that have been proved capable of passing on the character of high productivity to their budded offspring. One or two companies are now tapping clones that were propagated some years ago, when the practice of budding was first introduced into the country. If critics in those days had not condemned the innovation and discouraged managers from continuing their first trials, there would probably be a good selection of Borneo clones to choose from in the near future.

Selected seed from isolated gardens planted with high-yielding trees was imported by one company. Where local seed is used the best that can be done at present is to obtain it from good mother-trees—an inferior method of selection because nothing is known about the trees from which the pollen is derived. It is commoner, however, to take seed from high-yielding areas, which is still less satisfactory even if care is taken to choose areas from which the majority of the poor trees have been removed from successive thinnings.

The advice to plant closely and thus leave scope for selection when the trees are old enough to tap is not always followed. Close planting is especially desirable when unselected seed is used, for it has been proved that such yields give rise to a large preponderance of poor yielders: in tested areas 75 per cent. of the trees gave only 25 per cent. of the total crop.

## METHODS OF UPKEEP.

The fall in the price of rubber that occurred when the removal of Restriction was decided on threw into strong relief a fact that sometimes appears to be overlooked in good times, namely, that nothing increases earning-power more than a high yield per acre. The existence of areas where the growth of the trees is poor often lowers the average yield from an estate. Measures for the improvement of such trees aroused general interest during the year, and many companies undertook manuring work either experimentally or on a commercial scale.

It had been found in previous years that alluvial flats presented the simplest problem: a nitrogenous fertiliser (ammonium sulphate was the one used most) always has an immediate and satisfactory effect on growth. The problem of reviving trees on hills is more complicated, but it is gradually being solved. There prove to be considerable differences in hill soils. All require a nitrogenous fertiliser, but whereas some need nothing else others also lack phosphates and in one area potash had to be used as well. A lag in the action of fertilisers frequently introduces another difficulty; some experiments that were at first regarded as failures gave good results after a lapse of twelve months.

Small preliminary experiments are carried out to discover the fertiliser-requirements of any area that it is desired to manure, and stimulation of growth is taken as the criterion of success. Trees that are growing produce

* From *The Bulletin of the Rubber Growers' Association,* Vol. II, No. 7, July, 1929.

new shoots whereas trees whose growth is stationary do not; and new shoots can easily be distinguished from old shoots by the lighter colour of the leaves they bear. After about a year growth in the thickness of the trunk can also be observed. It is not necessary to take measurements: the surface of thin bark that was previously smooth and appeared to be glued down to the wood is broken by innumerable cracks, caused by the pressure exerted by new layers of tissue formed at the cambium; in thick bark the cracks are fewer but longer and deeper.

As renewed growth follows more generous feeding it is clear that the trees had deteriorated through starvation. And seeing that yields had declined as deterioration advanced there is every reason to believe that they will improve as the trees regain vigour. Definite proof of a higher yield is, not unnaturally, desired by most boards of directors. It is, however, impracticable to carry out scientific experiments to provide such proof without a big expenditure of time and money. The work would need supervision of a kind that cannot be secured under estate conditions, and unevenness in growth, spacing, and bark thickness renders inapplicable the figures as to experimental precision determined in the classical work done on H.A.P.M. in Sumatra. Crude yield-tests have been carried out on many estates and most of the results appear highly satisfactory. There are one or two exceptions, but it is legitimate to assume that a bad method of testing will sometimes make a good result into a seeming failure.

So long as silt-pits and similar devices are popular in neighbouring countries it is to be expected that Borneo planters will sometimes be recommended to construct them. Such a recommendation was made during the year but it led to nothing. Most estate managers have carried out experiments in the past, and since the growth of deteriorating trees has never shown the slightest improvement, the opinion is unanimous that silt-pits are a waste of money. Borneo experience has been with mature rubber. Complementary to this, evidences of a reaction are observable in F.M.S. scientific circles against both silt-pits and terraces in new clearings.

Under old rubber, except in areas that were clean-weeded for manuring, a cover consisting of mixed plants of low stature was maintained on most estates as a protection against wash. If such a cover is allowed to get too rank it does harm by competing with the trees; the effects of competition are most clearly manifested by rubber growing in poor soil. Experience has shown the soundness of the opinion expressed in one of these reports several years ago, that a mixed cover should be just thick enough to anchor the dead leaves that fall from the trees during wintering; a continuous sheet of dead leaves stops erosion, and while allowing rain-water to enter the soil is an obstacle to evaporation.

The superiority of leguminous covers to a mixed spontaneous growth is generally admitted, but replacement is expensive and not much progress was made during the year. Of covers that will grow in shade *Centrosema pubescens* perhaps shows most promise, but on one or two estates it has proved a slow starter. On hills, where serious erosion would result from the dying out of the cover, it would be wise not to trust to a single species but to mix several, and perhaps even to retain some plants that are not leguminous.

Though leguminous covers are useful under old rubber, it is in young plantations, where their growth is not retarded by shade, that their value is greatest. Land exhausted by repeated crops of tobacco furnishes the best examples. On several estates rubber grown by methods that were successful on other types of soil failed to come to maturity, but after a leguminous crop had been grown for a year or two (it was not dug in) the trees improved as if they had been manured, and in all cases they came

into bearing. On richer land leguminous covers do not observably affect growth, but they are recommended because they may increase the stock of soil-nitrogen and thus reduce the fertiliser bill in later years. *Mimosa invisa* is still the favourable cover for new clearings. Its prickles and the fact that it will burn when dry are drawbacks, but they do not seem to be considered serious by managers who have planted it on a big scale. Nevertheless the wisdom of looking for alternative covers is realised and several have been and are being tried.

## DISEASES AND PESTS.

There is a close connection between weather and the incidence of certain diseases, and on some estates that had heavy monsoon rains pink disease, mouldy rot and claret canker were troublesome. *Fomes lignosus* proved common in a few young clearings, and was also found in old rubber where its existence was not suspected until the trees were revived by manuring. Brown bast was local in its occurrence. In general, parasitic diseases were more prevalent than they have been for several years, but on few estates did they constitute an important problem.

The two chief pests were the pig and *Termes gestroi*, the white ant. The depredations of the former are limited to unprotected or imperfectly protected estates but a year rarely passes without losses being suffered and 1928 was no exception. The destructiveness of white ants is less patent; but as the pest is more generally distributed the sum-total of the damage it does is undoubtedly greater. Radical measures are the only ones likely to be completely successful against either pest; suitable fencing confers a high degree of immunity from damage by pig, and white ants are best guarded against by the total destruction of nidal wood—the unburnt remains of the jungle trees. Under special circumstances poisons may be a useful auxiliary method of combating either pest, but the danger of recommending them is that they appear at first sight to be cheap and may be adopted as the sole method. The cost of fencing a clean clearing can easily be worked out and is always formidable. On the other hand, calculating the total of the small amounts spent on poisons over a long period is a difficult piece of arithmetic into which optimism usually enters as a factor, and it is too often forgotten that the losses due to the relative ineffectiveness of palliatives should be addd to their cost.

# INVESTIGATIONS ON RUBBER IN 1928 AND 1929*

## BOTANY

BOBILIOFF several years ago made the attempt to find anatomical characteristics which could be correlated with the productivity of the tree and make it possible to distinguish by anatomical investigation the high-yielding trees from the low-yielders. He found a correlation between the number of latex rings and the yield, but this correlation was proved to be not close enough to allow of the use of the number of latex rings as a standard for the selection of high-yielders.

Ashplant claims to have found a more reliable standard in the diameter of the latex tube. For the measurement of this diameter he did not use the latex tubes of the bark, these being affected by the distorting effects of secondary growth, but those in the leaf stalk. The measurement can be made as well in 6 months old nursery plants (and perhaps also in younger ones) as in old trees. It is the opinion of Ashplant that the method would make it possible to eliminate nearly all those seedlings which would never be good yielders.

In his lecture before the Rubber Growers' Association, the speaker pointed out that he did not claim that the trees with the largest tube bore were necessarily the highest yielders, as there was the other important factor of ring number to be taken into account. He considered the tube diameter to be about 75% responsible for determining yield.

In a table the correlation of the yield of 231 trees, 9 years old, and the diameter of latex tubes is demonstrated. Amongst the lowest yielders (9 to 15 cc. latex per tapping) we see diameters of 11·5-13·5 micron (1 micron is 0·001 mm.), in the highest yielders (66-99 cc. of latex) diameters of 15·5 to 20·0 micron.

The lecturer said that in general no noteworthy improvement in the yields of rubber trees had been recorded from manuring. He concluded from this, that the factor in the tree that chiefly determines the latex yield is unaffected by manuring and therefore could not be very well of a physiological nature.

## THE SOIL

Kortleve investigated the acidity of 1260 samples of soil belonging to a great number of rubber estates, all situated in the Government "East Coast of Sumatra." Of each sample 10 grams of air-dried earth were very thoroughly mixed during six hours with 25 cc. of boiled distilled water. The following day the hydrogen concentration of the mixture was electrometrically determined with use of the method of Billmann. The reaction of the soils investigated by Kortleve may be learned from the following summary: pH 7-8 was found on 5 estates, pH 6-7 on 8 estates, pH 5-6 on 22 estates, pH 4-5 on 34 estates. From the investigation of Kortleve it appears, that the soils of the East Coast of Sumatra are mostly "acid" or "strongly acid." On all these acid soils Hevea develops equally well. Even on the soil with the strongest acidity (pH 3·13) the growth is excellent.

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* By Dr. C. J. J. van Hall in the *International Review of Agriculture, (Monthly Bulletin of Agricultural Science and Practice)*, April 1929.

In the alkaline soils the borderline between the soils with a good growth of Hevea and those with a poor growth is well defined: the soils with a good growth have an alkalinity less than pH 7·9; when the alkalinty is greater the growth is poor. It thus appears, that Hevea is unable to stand a large amount of lime or other alkalies in the soil. These conclusions show that there is no reason to fear that large amounts of acid manures, such as ammonium sulphate, might be detrimental to Hevea on account of their acidity and there seems no reason to replace them by alkaline manures, as Chili-saltpetre. On alkaline soils the use of ammonium sulphate is always to be preferred to that of Chili-saltpetre.

## MANURING

As a rule manuring was successful only in fields where the growth or the yield was poor, and it is remarkable that in cases in which the growth was good or even only satisfactory, manuring had no appreciable effect.

Of the manuring experiments in 1927 in Java and South Sumatra, de Vries gave a concise but complete review. The following list may give an impression of the results obtained; the figures indicate the number of experiments.

| | Increase in production obtained | Increase in growth obtained | Effect dubious | No effect | Total number of experiments |
|---|---|---|---|---|---|
| South Sumatra | 5 | 1 | — | 4 | 10 |
| West Java | 4 | 3 | 27 | 16 | 50 |
| Central Java | 2 | — | — | 1 | 3 |
| East Java: | | | | | |
| Besoeki | 1 | — | 1 | 1 | 3 |
| Malang | — | 1 | — | 5 | 6 |
| Total | 12 | 5 | 28 | 27 | 72 |

The great number of cases in which the effect of manuring is dubious or lacking (55 out of 72) is apparent. But on soils where the growth or the yield was poor, the effect was often very marked. This was, for instance, the case on worn-out soils in Bantam and the West Preanger (on "Djasinga Estate" an increase in the production of 25% was obtained, on "Soekamdjoe Estate" an increase of 40%).

More particulars of the results obtained at "Djasinga Estate" on poor soil were given by Mailette de Buy Wenninger. The growth was poor, crown development and bark renewal quite insufficient and the trees were suffering from die-back of the tops. The soil is stiff and known as "padas-soil." The trees were planted in 1910-11 and during the first nine years the development was normal, but then the decline began and the yield decreased from 6 gm. to 2 gm. rubber per tree per tapping. In 1925 the first application of 1¾ kg. ammonium sulphate per tree was given (in the month of July during the leaf-fall); this was repeated after 2 years. The effect is to be seen from the following figures:—

Increase in girth (average per year):—
before manuring (1923-24): 0·6 cm.
after manuring (1926-27): 2·9 cm.
Yield per tree per tapping:—
before manuring: 7·08 gm.
1st year after manuring: 8·35 gm.
2nd year after manuring: 12·38 gm.

The die-back stopped after the application of the manure and the trees obtained a well-developed crown. The beneficial influence of the ammonium sulphate did not last longer than 2 years.

Not all the backward fields at Djasinga Estate recovered completely after the application of ammonium sulphate and further manuring experiments are being made to find out what other element is deficient in the soil.

Striking results were obtained by Grantham at "Soengei Baleh Estate" (East Coast of Sumatra) with ammonium sulphate (see *Archief voor de Rubbercultuur in Nederlandsch—Indie.* Vol. II, p. 465, 1927). It may be recalled here, that on white alluvial soil, where the yield was poor, averaging 289 kg. per hectare a dressing of 630 kg. ammonium sulphate per hectare in 1920 and 1922 and of 2 kg. per tree in 1924 and 1926 resulted in a yield of 566 kg. per ha.

Arens tried different manures on poor soils (East Coast of Sumatra). The nitrogen manure (2 kg. of ammonium sulphate per tree gave an increased yield after one year (about 10% increase over the control), while the phosphorus and potassium manures had no appreciable effect. In these experiments of Arens—as in those of de Vries—no harm could be seen from the superphosphate, as Grantham and Schmole thought to have observed in their experiments. In one field, where the growth was exceedingly poor, the nitrogenous manure had no effect, but improvement was obtained by application of superphosphate. Arens' opinion is that red soils on which the growth is poor are in most cases deficient in nitrogen, but as it is sometimes phosphorus which is lacking, he recommends the inclusion of phosphorus in the experiments.

In Besoeki (East Java) manuring experiments have been started by van Dillen on the slopes of the Yang and the Merapi mountains where the yield is poor (about 200 kg. per ha.). Results have not yet been reported.

In the experiments of Grantham on red soils of average quality manuring did not increase the yield. Nitrogen, phosphorus, and potassium manures were equally ineffective.

In the manuring experiments of Maas at "Serpong Estate" (Tangerang, West Java) the nitrogen manuring had less effect than the combined potassium and phosphorus manuring. Every two years 200 kg. of chloride of potassium and 200 kg. of double superphosphate were given per ha.

As regards the time of application of the manure, it seems to follow from the experiments of Grantham, Maas and others, that the time of year is of little importance. At any rate no difference could be seen whether it was applied in the beginning of the rainy season or after this season, shortly before the leaf-fall.

Against these successful manuring experiments on poor soils, experiments without success on a soil of average quality may be mentioned.

De Vries gave a short progress report of manuring experiments with seedlings and young budded trees. The object was to stimulate the growth in order to be able to plant the seedlings in the field at an earlier date and to obtain bud-wood sooner from the inoculated plants. The experiments were made in two experiment gardens near Buitenzorg and on one estate near Soebang. The application of ammonium sulphate, superphosphate and potassium sulphate had no effect on the one to three months old seedlings. The doses used were: (1) 5 gm. per plant of each of the manures mentioned, applied 5 times; (2) 8 gm. ammonium sulphate, 4 gm. superphosphate and 4 gm. potassium sulphate per plant, in different combinations, applied 8 times, and (3) 20 gm. sulphate of ammonia, 20 gm. superphosphate and 10 gm. potassium sulphate, applied 15 times. The manuring of the inoculated plants also was quite unsuccessful. These plants belonged to different clones and were manured in different ways, viz. with: (1) 300 gm.

ammophos, (2) 600 gm.—1 kg. diammophos, (3) 1 kg. calcium cyanamide, (4) 1 kg. kapok seed-cake, (5) 25 gm. potassium sulphate, (6) 25 potassium sulphate and 50 ammonium sulphate (the manures mentioned under (5) and (6) were applied twice.)

In all these experiments the growth of the young plant could not be increased by manuring, but on a poor soil in Bantam manuring with different nitrogen and phosphorus manures had a very marked effect on young seedlings. Phosphorus was given as bone-meal and as superphosphate, nitrogen as ammonium sulphate and as seed-cake. The best results were obtained with seed-cake (100 gm. per tree) combined with bone-meal (50 gm.); the seedlings manured in this way obtained a height of 156% and a weight of 421% of the unmanured plants.

The influence of manuring on leaf-fall and leaf development has lately become a point of interest in connection with the mildew disease (*Oidium*). As Gandrup pointed out, it has been observed that trees manured with nitrogen drop their leaves later than non-manured trees, and accordingly they developed the new leaves later, but the development of new leaves is more rapid than in unmanured trees. While it is still dubious whether the later development of the young leaves has a favourable or an unfavourable influence on the development of the *Oidium*, it may be taken as settled that the quicker development of the leaves hinders the development of the fungus. Vollema pointed out that manured trees sometimes recover better from a mildew attack. In August 1927 a dose of 4 kg. ammonium sulphate per tree was given (the production increased by 15%) and a year later, in August 1928, the manured trees were more badly attacked by the fungus than the unmanured trees and the yield decreased accordingly, but three months later the manured trees had recovered from the attack and the yield had come up to that of the unmanured trees.

## GREEN MANURING

The use of green manures has for many years been popular in the Dutch East Indies and is becoming of more and more importance in the other rubber-growing countries.

For Ceylon Dias recommends the same green manures which are used in Java and Sumatra, viz., the shrubby *Tephrosia candida* and *Tephrosia Vogelii.*, and the creeping *Vigna oligosperma* (*Dolichos Hosei*), *Calopogonium mucunoides, Centrosema pubescens* and *Centrosema Plumieri.* It may be mentioned here that *Tephrosia Vogelii* is less recommended in the Dutch Indies than *Tephrosia candida* on account of its shorter life time and its not standing pruning, while *Centrosema Plumieri* grows badly on poor soils. Mitchell recommends also species of *Indigofera* and *Crotalaria.*

As *Vigna* grows better under shade, Dias recommends starting planting *Tephrosia candida* and *T. Vogelii* after the contour platforms are cut and when these are full grown, to plant *Vigna* under the shade of *Tephrosia. Vigna* cuttings of a length of 3 feet may be planted 4 or 5 together at a distance of 12 feet apart. Further cuttings may be taken from these patches and interplanted, this time 6 ft. by 6 ft. By this means, within a year to eighteen months of first planting a new clearing can be easily covered by *Vigna.*

Dias does not recommend the planting of *Desmodium.* It is considered to retard the growth of Hevea. This applies to two species, the small-leafed *Desmodium triflorum* and a large-leafed species, the Latin name of which was not given.

Mitchell referred to the problem of root diseases of rubber in association with cover crops. He pointed out that the growing of cover crops sometimes encourages the development of root diseases. Fungi such as *Fomes lignosus* and *Poria hypobrunnea* sometimes spread from one tree

to another along the roots of the cover crops; *Tephrosia* and *Crotalaria* especially are liable to attack by *Fomes lignosus*. This drawback, however, is more than counterbalanced by the advantage secured from the growing of cover crops.

Murray came to a similar conclusion. He found *Crotalaria* attacked by *Fomes lignosus, Fomes lamaoensis Diplodia* and *Rhizoctonia batati-cola*, and *Tephrosia* by *Fomes lignosus, Poria hypobrunnea* and *Ustulina*. Whereas with erect covers the spread of root diseases may be favoured by the cover plants, these being themselves liable to the disease, in the case of creeping covers the effect is more indirect, though possibly more marked; the spread of *Fomes lignosus* under a cover of *Vigna, Centrosema,* and *Calopogonium* is favoured by the moist condition of the surface layers of the soil and besides, the mycelial strands of *Fomes* like to spread along the stems and branches of the creeping covers, though the fungus does not seem to do harm to these plants. Murray recommends that cover crops, and in particular *Vigna hosei,* should not be grown in places known to be affected with root disease and, if already established, they should be cleared away.

## REJUVENATION

Rejuvenating rubber fields has become a problem since seeds and bud-wood of high-yielding trees have become available and since it has been proved that trees grown from this material give a much higher yield than the trees of the old fields, grown from seeds gathered at random. The old fields can be rejuvenated, either by cutting down the old trees and replanting entirely, or by thinning out the old fields and interplanting with young trees.

The last-mentioned method has the advantage that a loss of production during some four years is avoided. It has been followed on some estates, and Zwaardemaker and van Holst Pellecaan gave valuable information about the results obtained.

Zwaardemaker interplanted in 1915 a field of 3·1 bahu (2·2 ha.), containing 455 trees 9 years old with 1265 stumps, grown from selected seed at a distance of 13 by 13 feet. Gradually the old trees were thinned out; in 1919, 345 old trees were left and in 1928 only 46. Tapping of the young trees began in 1920, and in 1921 more than 50% of them were tapped, the rest in 1922 and 1923. This shows that the interplanted trees were not backward. The production of old trees amounted in 1916 to 233 kg. per bahu and went down to 140 kg. in 1920. In this year the young trees began to produce and the yield went up from 140 kg. in 1920 to 412 kg. per bahu in 1927. From these figures it is apparent that the system was economical. The old trees would never have given a yield of 412 kg.

In thinning out the old fields for the benefit of the young trees the difficulty is to decide which trees should be cut down. Van Holst Pellecaan follows the rule that, in fields with a yield of 400 kg. per bahu (about 570 kg. per ha.), the trees which yield less than an average of 50 ccm. of latex are immediately removed; the trees yielding 50-80 ccm. of latex are pruned and gradually removed, while those giving more than 80 ccm. of latex are left. He estimates that the expenses of this method amount to fl. 570 per ha. in 10 years.

The other method of rejuvenation—replanting entirely—was described by Koch. He proposes not to interplant between the old trees but to apply a drastic tapping system for two years and to replant in the third year. In the 6th year of the young trees tapping is begun. He considers that the old trees, when they are left standing, would produce in 18 years 3600 kg. rubber per bahu, while one would get from one bahu, if it is replanted with superior strains, in 18 consecutive years: 400, 400, 100 kg.

(from the old heavily tapped trees), —, —, —, —, (4 years without production), 120, 200, 270, 270, 340, 420, 460, 500, 500, 500, 500, kg. from the newly-planted trees or a total in 18 years of 4710 kg. The author estimates that in the first 10 years there is a loss of fl. 1002·93 per bahu; from that year the replanted fields give more profit than the old fields and the loss diminishes gradually, till there is a gain in the 18th year of about fl. 116·56. In this calculation it is taken that the old trees would give a yield of 200 kg. per bahu and the young ones a yield of 500 when full grown; the rate of interest is reckoned as 5% and the market price as 45 cents per ½ kg. (8·1 d. per lb.).

## SELECTION

It is not yet possible to give reliable figures of the yield per ha. which may be expected from the different clones and seedlings from selected mother-trees. There are relatively few available data concerning yield, obtained from small groups of trees, in some cases 5 trees, sometimes 10 to 20.

New figures about the production of seedlings from selected trees were given by de Vries.

At "Pataroeman Estate" 60 ha. were planted, in 1917 (43 ha.) and 1918 (17 ha.), with seeds obtained by natural ("illegitimate") pollination from selected trees. The yield was as follows:—

| Year | Number of trees tapped per ha. | Age of trees | Yield in kg. per ha. per year | Yield in kg. per tree per year. |
|---|---|---|---|---|
| 1923 | 230-210 | 6 | 340 | 1·47½ |
| 1924 | 210 | 7 | 497 | 2·36 |
| 1925 | 190-185 | 8 | 573 | 3·12 |
| 1926 | 185 | 9 | 700 | 3·79 |
| 1927 | 185 | 10 | 745 | 4·03 |

At "Pasir Waringin Estate" 21½ ha. were planted with seedlings obtained by natural pollination from selected trees. The production was as follows:—

| Year | Age of the trees | Yield in kg. per ha. |
|---|---|---|
| 1922 | 6½ | 390 |
| 1923 | 7½ | 600 |
| 1924 | 8½ | 666 |
| 1925 | 9½ | 820 |
| 1926 | 10½ | 717 |
| 1927 | 11½ | 703 |

At "Kiara Pajoeng Estate" a field was planted with seedlings obtained by natural pollination from selected trees. The production was as follows:—

| Mother-tree | Number of trees | Age of the trees | Yield per tree per tapping in grams. |
|---|---|---|---|
| PR 148 | 67 | 12 | 28·1 |
| PR 150 | 317 | 11 | 15·6 |
| PR 151 | 213 | 11 | 19·3 |
| PR 154 | 202 | 11 | 16·3 |
| PR 155 | 74 | 11 | 11·3 |

Seedlings from selected trees of "Kiara Pajoeng Estate," obtained by natural pollination, were planted in the Experiment Gardens of the Rubber Experiment Station. The production was as follows :—

| Mother-tree | Number of trees | Yield per tree per tapping 6th year | 7th year |
|---|---|---|---|
| PR 148 | 2-7 | 5·6 | 9·5 |
| PR 150 | 7-11 | 6·4 | 9·8 |
| PR 152 | 5-9 | 5·8 | 7·5 |
| PR 153 | 2-5 | 6·3 | 8·0 |
| — | 2-5 | 6·3 | 12·2 |

It is noteworthy that the clones from these mother-trees of "Kiara Pajoeng" gave much higher yields than the seedlings.

De Vries concludes from these figures that fields planted closely with seedlings of superior quality mother-trees may give after strong selective thinning out, when 9 years old, 700 kg. rubber per ha., which is much more than the average production of fields planted with trees from unselected seeds (400 to 500 kg. per ha).

Holder and Heusser and Heusser gave new figures about the yield of different clones and seedlings.

Holder and Heusser recorded the yield of seedlings of the highest yielding trees of the estate "Boekit Maradja" and of 7 clones of this estate. The clones had been budded in October 1922 and at the same time the seedlings had been planted out. The trees were tapped on the one-month periodical system. The planting distance was 24 x 24 feet. Tapping was begun in July 1926 and the results of the first year were as follows :—

| | Seedlings | Clone no. 80 | 51 | 152 | 71 | 76 | 163 | 174 |
|---|---|---|---|---|---|---|---|---|
| Total yield of 200 trees in the first year of tapping in kilograms. | 121·4 | 301·2 | 153·3 | 413·8 | 325·0 | 218·0 | 285·4 | 213·4 |
| Annual yield per tree in kilograms. | 0·61 | 1·51 | 0·77 | 2·07 | 1·62 | 1·09 | 1·43 | 1·07 |
| Average yield per tapping per tree in grams. | 3·75 | 9·33 | 4·73 | 12·76 | 10·03 | 6·73 | 8·80 | 6·58 |

From these figures it is apparent that the average yield of the clones altogether is 2½ times greater than that of the seedlings. The average circumference per tree at a height of 1 meter varies in the clones between 54·6 cm. (clone 76) and 59·3 (clone 51), against 63·3 cm. of the seedlings.

The average rubber content was lowest for clone 163 (27·4%) and highest for clone 51 (32·0%), for the seedlings it was 31·8%.

Heusser published the results of experimental tapping of clones of the "Avros Experiment Station." The clones 33, 49, 50, 52, and 80 were planted in 1919 (some trees of nos. 33, 50, 52 and 80 in 1929 and one tree of 33 in 1921) and clone 36 in 1920 (one tree in 1921). The numbers of trees tapped were: 10, 10, 4, 10, 11, and 8. Tapping was done from May 1926 to September 1927 for the clones 33 and 50, and from April

1926 to August 1927 for the other four clones. The one-month periodical tapping method was followed. The average yield per tapping per tree was as follows :—

| Clone No. | Grams | Clone No. | Grams |
|---|---|---|---|
| 33 | 24·0 | 50 | 29·4 |
| 36 | 26·1 | 52 | 76·5 |
| 49 | 32·3 | 80 | 26·2 |

Heusser gives also figures of the result of experimental tapping at the estate "Tjinta Radja." Figures were given of the yields of seedlings (36 x 35), seedlings 49 (natural), seedlings from selected trees, and the clones 40, 35, 27, 28, 139 and 36, tapped during one year (1926-1927) with the one-month periodical system. The number of trees was in the three seedling experiments : 18-21, 10-24, 227-289 and for the clones 108-111, 217-236, 99-107, 107-123, 66-79, and 37-40. The following yields were obtained.

Yield per annum (149 tapping days) in kg. of dry rubber per tree.

| Seedlings | | | Clones | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cross 36 x 35 | Natural 49 | Selected Seeds | 49 | 35 | 27 | 28 | 139 | 36 |
| 5·28 | 3·56 | 1·57 | 3·70 | 3·17 | 2·77 | 2·70 | 2·10 | 2·75 |

Heusser points out that the number of trees of the cross 36 x 35 and of the natural seedlings 49 was too small to give a reliable average, and that only the average per annum of the seedlings of selected trees and the clones can be compared. It is apparent that this comparison leads to the conclusion that the yield of the clones was much higher than that of the seedlings.

## PRACTICE OF BUDDING

Budding may be done in the nursery or in the field. If the tree is budded in the nursery it may be planted out immediately after the bud is fixed (some 23 weeks after budding), or the bud may be left sleeping for some time, or the bud may be allowed to grow out and the new stem may be stumped.

The advantages of stumping the budded trees before planting out were advocated by de Graaf. His opinion is that with this method the number of plants which die after being planted out is smaller than when the plants are planted out in the field a few weeks after being budded.

Nieuwpoort objected to the method of stumping the budded plants. He pointed out that it takes at least three months for the stumps to begin to make a new shoot, and in his opinion the death rate of the stumps after being planted out is often very high. In some cases 50% must be replanted, either the whole plant or the shoot of the bud having died.

The question, whether it is preferable to bud in the nursery and plant out three weeks after budding, or to bud in the field was discussed by de Vries. He recorded results obtained by the two methods. Budding in the field has the advantage that the growth of the young shoot is not interrupted by transplanting so that after one year the shoot is of a fair size, which is especially advantageous when it must be used for bud-wood. A drawback of this method is that the budded trees in the field require much care and supervision.

De Vries describes a trial of budding transplanted seedling-stumps. One hundred seedlings, about one inch thick, were transplanted after having been stumped in the ordinary way at a height of 1 metre. They began to shoot after about three months. Budding was tried 10 days after transplanting, and then again every 10 days, but even three months after transplanting was still unsuccessful. Only 8 to 9 months after transplanting (5 to 6 months after shooting had begun) when the shoots had attained a length of two metres or more, was budding really successful.

## TAPPING RESULTS

The results of different tapping systems were compared by Bally in Malang (East Java). In newly-tapped fields no difference was found between the yield obtained by periodical tapping with the one-month system (one-month tapping, one-month rest) and the alternate day tapping. After 22 months the periodical tapping with the one-month system was changed into the two-week periodical system, from the third month the plots with alternate fortnight tapping yielded about 30% more than the alternate day tapped plots. In this experiment tapping was done over ½ circumference.

In another experiment the methods of alternate month tapping and alternate day tapping were once more compared. But here tapping was done over ⅓ circumference. The fields were in the 4th and in the 5th tapping year. The experimental tapping was continued for three years. In this time the alternate month tapping gave gradually better results: while the yield of the alternate day tapped trees decreased from 100 in 1925 to 84·7 in 1926 and 91·5 in 1927, the alternate month tapping gave the following increase: 100, 107·0, 130·8.

In a third experiment alternate day tapping was compared with 20-days periodical tapping. No difference in yield was found.

Extensive experiments with five different tapping systems were described by van Baalen. The following systems were tried: *A.* alternate day tapping over ½ the circumference; *B.* alternate day over ⅓ circumference; *C.* every third-day over ½ circumference; *D.* 20-days periodical tapping over ½ circumference; *E.* one-month periodical tapping over ⅓ circumference. The utmost care was taken to ensure reliable results. The experiment was started in April 1925 and finished in June 1928, lasting more than three years.

In these experiments the 20-days periodical system over ½ circumference and the alternate day tapping over ½ circumference gave a yield 20% higher than the 30-days periodical and the alternate day system over ⅓ circumference, though in the last of the three experimental years the results of tapping over ⅓ circumference was slightly improving.

Periodical tapping both when applied over ⅓ and over ½ circumference gave higher yield (3% more) than alternate day tapping over ⅓ and over ½ circumference. In this respect the result of these experiments corresponds with the results of Maas' experiments (*Archief voor de Rubbercultuur* 1925 and 1926) and is opposed to the above-mentioned result obtained by Bally.

When the one-month periodical system was applied, the highest daily yield was obtained on the 24th day, and when the 20-days periodical system was applied on the 12th day.

Tapping over ½ circumference gave more brown-bast disease than tapping over ⅓ circumference. The diseased trees were not left untapped but the cut was reduced to half its length. By this means the disease was stopped and the diseased trees produced 80-90% of the yield of healthy trees.

As to the economy of the different systems the author concludes that alternate day tapping or 20-days periodical tapping are the most economical systems.

Arisz published an important paper on the osmotic and other physiological factors, which play a rôle in the flow of the latex when a tree is tapped. But the paper is of more theoretical than practical interest. The same may be said of the paper of Schweizer on the connection between the time of flowing of the latex after tapping and the tapping system. In this paper Schweizer gave interesting figures showing the rather close correlation between time of flowing of the latex and yield of the tree; in his investigation of some 27 trees a yield of 30 cc. corresponded with a flow of about 20 minutes, a yield of 50 cc. with a flow of about 60 minutes, a yield of 70 cc. with a flow of about 90 minutes. A correlation of the same sort exists between the different tapping systems and the latex flow: the systems with the longer time of latex flow give the highest yields. In one experiment the daily tapping over $\frac{1}{3}$ had an average latex flow of 70 minutes, the every third day tapping over $\frac{1}{2}$ had an average of 120 minutes.

The stopping of the latex flow is not the consequence of a new equilibrium between the open vessels and the surrounding cells, but simply a consequence of the latex vessels being blocked by the coagulating latex on the tapping cut. Small stops of rubber close the vessels near the tapping cut. As soon as these are removed the latex flow begins anew. Schweizer mentions the experiment of a planter who tapped a tree during the day, opened the tapping cut again as soon as the rubber flow had stopped, and was able to tap the tree in this way 23 times during that same day; with the 10th tapping 75% of the yield of the first tapping was obtained and the 23rd tapping gave 50% of this yield. Schweizer tapped a tree 4 times immediately in succession and obtained the following yields:—

1st tapping: production 70 cc. latex of 30·5% rubber, time of flowing two hours;

2nd tapping: production 70 cc. latex of 30·3% rubber, time of flowing 2 hours 20 minutes;

3rd tapping: production 70 cc. latex of 30·1% rubber, time of flowing 2 hours and 30 minutes;

4th tapping: production 70 cc. latex of 27·5% rubber, time of flowing 2 hours and 41 minutes.

# THE COCONUT PALM: SELECTION OF SUPERIOR TREES *

BREEDING superior stock means breeding coconut trees with an average yearly yield of oil higher than the present average. It would take a very long time and much expense to analyse meat of all the good trees on a plantation in order to find the highest yielders, but it is generally taken for granted that a tree with a large number of large nuts with thick kernel will produce a large quantity of oil. This may eventually be found not to be the case. Such an assumption, however, simplifies greatly the selection of trees for breeding. Since the acid test is a large average yield of copra per acre, trees must be sought which produce a large number of large nuts of a thin husk and a thick kernel, and which lend themselves to close planting. Trees just coming into bearing should not be selected, because an optimum or maximum production is not reached for several years after the first spathe appears, or that, at least, is the general opinion of authors.

When a number of trees of apparent high yield have been selected their relative merits can be more accurately gauged by calculating the theoretical yearly yield of wet copra which would be produced per acre if the trees under consideration were reduplicated in plantations. If all the ripe nuts obtainable for each tree be measured and weighed and the wet copra cut from such nuts be weighed, an average weight of whole nut and an average weight of copra per nut can be obtained for the several trees. To estimate the number of nuts which the several trees will produce in a year all visible nuts of every age should be counted for each tree, that number divided by the number of spadices involved (to get the number per spadix) and then multiplied by twelve (as one spathe is put forth each month). A third factor to be determined is the number of trees of the patterns selected which could be grown per acre of land. The theoretical yearly yield then is the product of these three factors, viz., the average weight of wet copra per nut, the estimated number of nuts per year, and the estimated number of trees per acre.

All these high yielders are subsequently selected on the basis of habit, shape, density or openness of the crown, length and thickness of the midribs, length of spathe, also number and placing of the female flowers. Here the diagrams of the spadices of each tree are of great help showing numbers, irregularities, if any, and whether a tree tends to "go off" sometimes, as the planters call it, when a tree stops producing female flowers and even spathes temporarily. All the diagrams of the Malayan Dwarfs are alike, proving that this variety approximates a pure line, which made selecting very easy, because only the healthiest and strongest trees were to be picked. Similar diagrams were made of apparently the best Niu Lekas, and from the diagrams were chosen those which showed a large number of female flowers with the greatest regularity, and with a tendency to increase the number of female flowers, and to produce more than one female flower on the same branchlet. The same selection was applied to the Rotumans at Nagasau where two superior trees were selected.

* Extracted from an article by H. Marechal in the *Agricultural Journal of Fiji*, Vol. I, No. 2. 1928.

The number of trees per acre varies with the variety. The usual distance in Fiji for common coconut is 30 feet, but many Niu Lekas do not require more than 24 or 25 feet while Malayan Dwarfs on account of the short leaves may be planted at 20 feet.

In the following table the theoretical yearly yields of wet copra per acre are calculated for the trees which were selected for breeding improved stock :—

| Coconut variety | Average total weight per nut | Average weight of meat per nut | Average number of nuts per tree | Yearly yield of wet copra per tree | Planting distance in feet | Number of trees per acre | Theoretical yearly yield wet copra per tree |
|---|---|---|---|---|---|---|---|
| | lb. oz. | lb. oz. | | lb. | | | lb. |
| Malayan Dwarf | 2-12⅜ | 0-12¾ | 72 | 57⅜ | 20 | 108 | 6,196½ |
| Niu Leka C.o. | 5-99 | 1- 4 | 90 | 112½ | 30 | 48 | 5,400 |
| Niu Leka E.3. | 3-15 | 0-15 | 106 | 100 | 30 | 48 | 4,800 |
| Rotuma Green | 5-12 | 1-10 | 78 | 126¾ | 30 | 48 | 6,084 |
| Rotuma, Red | 4- 2½ | 1- 2⅔ | 60 | 70 | 30 | 48 | 3,360 |
| Common Coconut | — | 1- 0 | 42 | 42 | 30 | 48 | 2,016 |

These yield figures obtained by multiplication are naturally very unreliable and consequently can be used only comparatively. When comparing these yields with those of the average plantation tree producing 42 nuts per year and having an average of 1 lb. of wet copra per nut, which is probably too high, it will be seen that they are all much higher.

The practice of selecting useful parent trees by sight, even considering the inflorescence and the yearly yield of copra, does not guarantee a uniform plantation. The seedlings of the same parent trees will vary considerably on account of uncontrolled cross-pollination. Only by cross-pollination or selfing practised on the parent trees artificially is a more uniform offspring to be expected, although even then the influence of the grand-parents will be noticeable. Intercrossing of the daughter-trees is then the means of eliminating undesirable qualities.

# THE PINEAPPLE INDUSTRY IN MALAYA *

## PRODUCTS AND BY-PRODUCTS

"9th August 1661. I first saw the famous Queen Pine brought from Barbadoes, and presented to His Majesty; but the first that were ever seen in England were those sent to Cromwell four years since."

This passage from Evelyn's *Diary* is of interest as being one of the earliest references, possibly the first reference, to the Pineapple in English literature. Later in his *Diary,* Evelyn records that he first saw the "King-pine" in 1668, a slice of which was graciously given him by Charles II. He does not appear to have appreciated its flavour as much as he anticipated.

In those days, pineapples were a great rarity. Today, the fresh fruit is still regarded in England as being rather a luxury; but the canned fruits are eaten by rich and poor alike, and have become a very important item of commerce. During the past few years, there has been a big increase in the consumption of fruit per head of population in this country. The "Eat more Fruit" campaign is having its effect, and the sale of tinned pineapples is likely to rise still further, especially as the fact becomes more widely known that the fruit can be very usefully employed to flavour a great variety of dishes, including salads, puddings, and curries. In this connection a little book containing fifty pineapple recipes recently published by The Malay States Information Agency, should be of considerable interest to housewives, and will no doubt assist in making tinned pineapples more popular than ever.

The pineapple, *Annaas sativus,* a member of the Natural Order *Bromeliaceae,* is a native of Tropical America, and is widely cultivated in countries having a sufficiently hot climate for the purpose. It requires plenty of both heat and rain, and a well-drained and porous soil, which should however, not be too rich, as excessive richness favours large fruit at the expense of flavour. Excess of either lime or manganese in the soil is very injurious, causing the leaves to turn yellow and the fruit not to develop properly.

*Cultivation and Varieties.*—Many varieties have been produced by cultivation, which may be divided into three groups, namely the "Queen" group, the "Cayenne" and the "Spanish," differing in the size, colour and flavour of their fruits. These usually vary in weight from 1 lb. to 15 lb. according to the variety, though immense pines, weighing as much as 20 lb., have also been produced.

The plant is a low-growing one, attaining a height of from 2 to 4 feet. It produces a rosette of long, spear-like leaves, pointed at the ends and often spiny on the edges. From the centre arises a single stem, bearing a close spike of lavender-coloured blooms, supported by bracts, which, becoming fleshy and massed together, constitute the "fruit." In the wild state, and sometimes under cultivation, when the seeds come to maturity, these form little black or brown bodies buried in the pine just below the surface. It has been suggested that the formation of the "pine," which occurs after fertilisation, is designed to secure distribution of the seeds by the agency of certain animals, who, attracted by its perfume, devour the soft and luscious fruit and drop the seeds.

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* By H. Stanley Redgrove, B.Sc., A.I.C., in *Empire Production and Export,* No. 155, July, 1929.

At the first crop, only one fruit per plant is produced, but later crops may yield twice this number, exceptional plants sometimes producing even more than two fruits each.

Malaya has a climate singularly well adapted to the cultivation of the pineapple, and the canned pineapple industry of the Malay States has now assumed a position of considerable importance. In 1927, over 10,000 tons of pineapples were exported, valued at about one mlllion sterling. About 34,000 tons came to the United Kingdom, "Singapore" pineapples being well known to British housewives and much appreciated on account of their excellent flavour. As a matter of fact, however, the name "Singapore" is rather a misnomer; for whilst there are at the moment two canning factories at Singapore, the centre of the industry is at Johore, where there are eight factories. There is also one factory at Selangor.

*The Malayan Industry.*—The variety chiefly grown is of the "Queen" type, similar to the "Red Jamaican Pine" of the West Indies. This average about 3 to 5 lb. in weight and is of singularly delicious flavour. Care is taken to ensure a uniform good quality in the canned pines, which are put up in various forms, chunks, perhaps, being the most popular, and in tins of various dimensions. Three grades are recognised. "G.A.Q." (Good Average Quality) consists of good ripe pines; "Golden Special" of pines of superfine quality in point of ripeness; whilst slightly over-ripe or under-ripe pine are graded as "No. 2." These last are exported to China; they do not come on the English market.

It is a particularly interesting feature of the pineapple industry of Malaya, that, although there are a few cultivations given over exclusively to pineapples, the fruits are grown chiefly as a catch crop on rubber plantations. The cultivation of the pines is mainly in the hands of Chinese, the common arrangement being for Chinese settlers of the labouring class to carry out the whole work of the plantation from planting until the rubber comes into bearing in return for the proceeds of the pineapple catch crop.

The plants are propagated by means of suckers, which are placed in the fields in rows about five feet apart, about 3,000 plants being thus required per acre. Eighteen months are required for the production of the first crop of one fruit per plant. Afterwards an average crop of nearly twice this, or about 5,000 fruits per acre, may be expected. With careful management, a plant will continue to yield for five or even six years, by which time the growth of the rubber trees and consequent shade weakens the pineapple plants and necessitates their removal.

*Process of Canning.*—The canning factories are situated close to the fields, an advantageous circumstance because it allows the fruits to be canned when perfectly ripe, only an interval of thirty hours elapsing between harvesting and canning. Another favourable circumstance is the fact that first grade cane-sugar is easily obtainable in bulk, supplies coming mainly from the Dutch East Indies, which is only one day's journey from Singapore. Canning is effected by placing the pineapples, after grading and cutting into shape, into tins with sugar syrup. The tins are soldered up and plunged into the boiling water for ten minutes or more, after which they are punctured to allow steam to escape, resoldered and again plunged into boiling water for a short time. The pineapple has a high vitamin content, and it is claimed that the method of canning ensures very little damage from this point of view, a matter of high importance in view of the valuable character of the water-soluble vitamin.

The canning industry of Malaya is largely in the hands of Chinese, whose complicated labour system makes it difficult, if not impossible, to arrive at any satisfactory estimate of the cost of canning. That labour is obtained very cheaply is an incontestable fact, the price of Malayan tinned pineapples comparing very favourably with those obtained from any other part of the world.

Nevertheless the present system is exceedingly wasteful both of labour and material, and one might suggest that the moment is ripe for the establishment of a modern factory, equipped with canning machinery constructed on scientific lines and adequate plant for dealing with the waste material, controlled by British capital.

*The Problems of Wastage.*—The wastage is enormous. In order to place a really good tinned pineapple on the market, and it must be cordially admitted that the Chinese packers have done this, not only must rotten, under-ripe and defective pineapples be rejected, but the pines have to be cut to shape. As a matter of fact, about two-thirds of the material in the form of pines which enters the factories leaves them in the form of waste.

This waste is simply dumped in heaps, where it provides a happy breeding ground for flies and other pests. With enterprise, taking advantage of scientific knowledge, this waste material could be worked up for the production of a number of useful and valuable commodities.

The fresh waste has been found to contain upwards of 90 per cent. of water, the liquor being rich in sugar (about 6 per cent.). This could be fermented and converted into alcohol. By concentrating the liquor until its sugar content was about 15 per cent., fermenting with toddy yeast, and afterwards distilling, Messrs. Greenstreet and Teik have obtained a potable spirit, resembling *Samsu,* a spirit made by the Chinese from rice, but containing rather more alcohol, nearly 35 per cent., as compared with 27½ per cent. in *Samsu.* Apart from the production of a potable spirit from pineapple waste, the manufacture from it of technical alcohol presents itself as an important possibility.

The same authorities have found that the ash obtained by the incineration of the solid part of pineapple waste contained 23¾ per cent. of potash and nearly 6 per cent. of phosphoric acid. Its utility as a manure is therefore strongly indicated. Another way of turning it to use would be, as in Hawaii, to employ it for the manufacture of cattle food. Dr. Henke has shown that Hawaiian "pineapple bran," which is a pleasantly-odorous granular material, contains 42 per cent. of starch, nearly 12 per cent. of sugar and over 3½ per cent. of protein. It is also said to be rich in vitamins.

The possibility of extracting citric acid, a very valuable product, from the waste liquors should also not be lost sight of.

In short, it may be said that whilst the Malayan pineapple industry presents certain features of great interest, especially the growing of pineapples as a catch crop, whereby the cost of production is kept at the lowest possible level, and whilst, too, it has succeeded in placing on the market exceedingly good canned pines at a very low figure, the industry would seem to be capable of further developments, and presents possibilities of which those alive to the importance of science as applied to industry, should not be slow to take advantage.

# TUNG OIL OR CHINESE WOOD OIL *

*Chinese Wood Oil.*—The news edition of *Industrial and Engineering Chemistry* (1929, 10th May, p.5) contains an article entitled "A Florida Tung Oil Project," by Mr. B. F. Williamson, which is not only interesting, but in my opinion deserves the close attention of those who are interested in the growing of agricultural products suitable to the conditions of sub-tropical climates. Chinese wood oil or tung oil, as it is also called, is the most durable and waterproof of all paint and varnish oils, and it is largely used in China in many places where rubber is used in Europe or in America.

*Uses of Tung Oil.*—In China it is used to produce the high finish on the Chinese junks and river boats; it is applied to all forms of wood structures, is used for waterproofing paper for Chinese parasols, silks and all kinds of cloth materials and masonry. Occasionally in the back country it is sometimes used for lighting in lamps and for soap. With regard to its use as paint oil it is stated in the article mentioned above that the United States import some 75,000,000 dollars worth of paint oil every year, and of this total some 12-15,000,000 dollars represent imported tung oil. Apart from its use as a paint oil it is employed in the manufacture of brake bands for motor cars, sheet packings and insulations. If more paint oil were available, it is held that the linoleum and oil cloth trades would use more of it. The demand, it is stated, is constantly increasing and is far in excess of the available supply. According to Mr. Williamson the demand is such that it will be many years before production catches up with the same, and it is stated quite positively that it is impossible to increase the production or improve the quality in China.

*An American Enterprise.*—It would seem that experts in America have been studying this matter for a number of years, and, after making planting experiments in various parts of the United States, they have come to the conclusion that the best growth and yield is to be obtained in North-Central Florida. Put quite briefly, I gather that the American industry is now on a commercial basis, and that it is claimed that by modern methods the yields of the oil from the fruit is much improved. As regards quality it would appear that much of the oil exported from China is adulterated. It seems to me that the position with regard to the wood oil industry for which undoubtedly there should be a great future, is similar to that which existed in the very early stages of the plantation rubber industry.

*Cultivation in the British Empire.*—That British scientists are also awake to the advantages to be derived from a thorough study of tung oil is shown by the fact that the Research Association of British Paint, Colour and Varnish Manufacturers have instituted a research into the cultivation of the product in the British Empire. The investigations and experiments will have to proceed much further before a final judgment can be formed, but already the conclusion has been reached that "there are undoubtedly parts of the Empire climatically suitable for the growth of tung oil trees and where the value of the land and the cost of native labour will ensure a relatively greater margin of safety to this enterprise than even in America."

* By Dr. P. Schidrowitz, in *The India-Rubber Journal* of July 13, 1929.

# THE CULTIVATION OF KAPOK

## DEPARTMENT OF AGRICULTURE, CEYLON, LEAFLET, NO. 52.

KAPOK is the floss obtained from pods of *Eriodendron anfractuosum,* which is one of the two well-known "cotton trees" in the Island. This tree bears greenish-white flowers and is easily distinguishable from the other *Bombax Malabaricum,* the flowers of which are red. The floss of Bombax is more silky and is largely exported from India, where it is also used sometimes for mixing with kapok. The floss of these cotton trees is not attached to the seeds, which are free, as in the case of the lint of ordinary cotton which is the product of species of *Gossypium.*

Kapok is common as a boundary and fence tree, and is usually seen in mixed cultivations. As a pure crop it is likely to give profitable results only where conditions are specially favourable to the production of a high yield and where land values are comparatively low. It is suitable for cultivation as a pure-crop in certain parts of the Dry Zone. It may be grown in plantations of cacao, coffee, sisal, limes, pepper, vanilla, &c.

It should be planted 18 feet by 18 feet on good land, and 16 by 16 feet if the soil is poor.

### CLIMATE AND SOIL

Kapok will grow from sea-level to elevations of 2,500 feet or more, but best results are obtained at low and intermediate elevations below 1,500 feet.

Kapok flourishes under a wide range of conditions. It is able to withstand a long period of drought. But the ideal conditions are abundant rain during the growing season, and a dry period from the time the flowers set until the pods are harvested. A long spell of wet or even damp weather during the later stages of pod formation will reduce the quality of the fibre. Exposed situations are not suitable, as the branches which are quick growing are liable to be easily broken or damaged by high winds.

The best soil is a deep, porous, sandy loam which is well-drained. Kapok will not thrive on a heavy soil which tends to remain too wet. Since a high crop yield is required, the soil should be of a fairly high degree of fertility.

### PROPAGATION

Kapok may be propagated by seed or cuttings. Cuttings should be 1-2 inches in diameter and 4-6 feet long; and older than the present year's growth. Large cuttings have been found to give better results than small ones. Cuttings should be planted in the field as soon as possible after they have been cut, and should be inserted 12-18 inches deep acco ding to size.

An advantage claimed for cuttings is that the trees come into bearing sooner than those raised from seed; but experience shows that there may be two disadvantages: trees raised from cuttings do not possess a tap root, and therefore are liable to be blown over by heavy wind; and cuttings are in danger of attack by termites.

Plants raised from seed are stated to bear for a longer period than those raised by cuttings. Moreover, they are not liable to be blown down by the wind since they develop a tap root. Plants from seed are quick-growing under favourable conditions and may attain a height of 15-20 feet at the end of two years.

It is most important that seed should be collected from selected high-yielding trees with large pods. Seed should be fresh and should be tested by soaking in water before sowing. If the seed does not sink at first, it will be found that good seed will do so after soaking overnight. Light seed should be discarded.

Six pounds of seed should be sufficient for planting out an acre of land.

Nursery beds should be well prepared and made 3½-4 feet wide. The seed is sown in rows 10-12 inches apart, and after two months the seedlings should be thinned to a distance of 6-8 inches. The beds should be lightly shaded till the seedlings are 5-6 inches high and are fit to bear exposure to the sun. Shade should not however be prolonged, as the seedlings then tend to become lanky.

The seed germinate in a few days, and the seedlings make rapid growth. After thinning the space between the rows should occasionally be lightly forked. The application of liquid manure will be very beneficial. At the end of six months the seedlings will be ready for planting out.

Seedlings which are lifted for transplanting should be topped; all leaves should be removed, and the roots should not be damaged. They should be planted out at once, preferably in showery weather, in holes dug 18 feet by 18 feet in the field.

When the plants are 10-15 feet in height they should be topped in order to encourage the spread laterally of the branches and to facilitate picking the crop. Such topped plants branch well and produce a crop within easy reach.

Once the plants have become established, very little cultivation is required. For the first few months the soil around the plants should be kept clean weeded and loose. Subsequent weeding could be effectively reduced by means of a leguminous cover crop which can further be used for improving the condition of the soil.

From the fifth to the eighth year it is estimated that a total weight of 1,500-3,000 lb. of material in husk, seed, floss and the cores of the pods is removed annually. The husk and cores of the pods, which together weigh 700-1,400 lb., should be dug into the ground around the trees.

## HARVESTING AND YIELDS

Under the most favourable conditions a small picking may take place at the end of the second year; but usually it is not till after three years that kapok begins to yield regularly. The trees are at their best after the eighth year. A plantation is estimated to yield a profitable return for fifteen years.

The tree is in flower in December-February, and pods ripen during the ensuing dry weather. The harvest lasts for a period of three months during April-June.

The pods are collected as they drop, in a dry state, when the weather is fine. If it is damp or wet during the ripening period, the pods should be picked as they mature. It is not possible to climb the tree as the branches are weak and give way. Therefore picking is carried out by severing the stalks by means of a knife attached to a long pole. As the pods ripen they change colour from light-green to light-brown, at the

same time the smooth surface becomes wrinkled. It is at this stage that the pods should be harvested before they open at both ends and expose the floss. The whole crop should not be harvested at once, as this would result in a mixture of pods of different degrees of maturity, and consequently the floss would be of uneven quality and of lower value.

After picking the pods should be spread on a dry floor for a few days till they ripen thoroughly, and the floss should be removed as soon as possible. The number of pods per tree has been found to vary from 100-800; and the following figures may be taken as representing the average annual yield per tree and per acre on a plantation of 134 trees, planted 18 feet by 18 feet:—

| Age | No. of Pods per Tree | Floss lb. per Tree | Floss lb. per Acre |
|---|---|---|---|
| 3-4 years | 100 | 1 | 134 |
| 5-6 years | 200 | 2 | 268 |
| 7-8 years | 400 | 4 | 536 |
| 10 years | 600 | 6 | 804 |

100 pods give 1 lb. of floss.

The relative proportions of the different parts of the pods are:—

| | Per cent. | | Per cent. |
|---|---|---|---|
| Husk or shell | 42 | Cores | 18 |
| Seed | 23 | Floss | 17 |

## PREPARATION OF FLOSS

The initial process consists of the opening of the pods and removal of floss with the seed within from the core and the husk. This is done by hand chiefly by women and children who beat the dry pods with short stout sticks.

The more important process of preparing the product for the market is the separation of the floss from the seeds. Under village conditions simple methods are practised; but at commercial centres machinery is largely employed.

A quantity of floss with seed is placed on a perforated platform and beaten with bamboo sticks wielded in a horizontal direction so that the seed which is loosened falls through. The top layer is then removed and given a further beating on another platform, after which the floss is ready for bailing.

A second method is to place the floss as it comes out of the pods in a bamboo basket or box with perforated base, and stir it up by a paddle-like arrangement revolved within by means of a handle.

These hand methods are only in use where kapok is produced on a comparatively small scale.

Most of the machines employed consist of a horizontal chamber with perforated bottom in which the floss is beaten up by a series of blades revolving close to fixed blades on the sides of the chamber. The blades are so arranged that the floss moves along to the end of the chamber, where it is either blown out by fans or falls into receptacles.

The *Bley* machine, considered to be one of the best on the market, is claimed to clean 450-500 lb. of floss per hour and requires 1 horse-power for its operation.

The *Becker* machine works on the same principle as the above, but differs in possessing a chamber placed vertically. It is claimed that this machine cleans about 250-300 lb. of floss per hour.

The *Lienau* machine is a small one requiring from ½-1 horse-power for operation, and will clean about 250 lb. of floss in a day of eight hours.

The "France" machine designed by *Michotte* will clean about 125 lb. of floss per hour. The power required is stated to be less than 2 horse-power.

## GRADING AND BALING

Kapok should be graded carefully before bailing for export. As a rule four grades of cleaned kapok are recognized :—

(1) *Superior* or *extra,* containing less than 0·5 per cent. seed.

(2) *Prime,* containing not more than 2 per cent. seed.

(3) *Fair average,* with not more than 3½ per cent. seed.

(4) *Damaged.*

Owing to the bulky nature of the material the floss is pressed into the bales. Too much pressure must be avoided, especially with the finest quality, otherwise the elasticity of the fibre will be destroyed. Machine-cleaned very dry fibre requires more pressure than hand-cleaned, but on the average the pressure should not exceed 140 lb. per square inch.

The bales are generally packed in gunny cloth or matting and bound with hoop-iron.

The weight of bales range from 80-120 lb. and the size from 8-16 cubic feet.

## USES

The chief uses for kapok are for stuffiing cushions, pillows, mattresses, &c. It is well adapted for this purpose on account of its lightness, its springy or resilient nature, and its non-hygroscopic and non-absorbent characters. It is also largely employed in life-saving appliances.

## PESTS AND DISEASES

Among the worst enemies of kapok is the parasitic flowering plant *Loranthus.* The parasite should be looked for and removed in the early stage of attack.

Bats and squirrels may sometimes do considerable damage by eating the green pods or growing shoots.

Termites may be a serious pest, especially to young plants, and particularly those propagated from cuttings.

The cotton bug (*Dysdercus cingulatus*) which punctures the boll and stains the lint sometimes attacks the pods of kapok; but the damage is slight.

The grub of a beetle (*Batocera rubra*) is an occasional borer into the stem and twigs.

Among fungus diseases are Root disease and Pink disease. In the case of the former disease the proximity of cacao and kapok to each other is dangerous. Pink disease is liable to break out at the commencement of the monsoon. It commences in the fork of a branch, and if attended to early may be prevented from spreading round the branch and killing it.

## BY-PRODUCTS

Hitherto interest in kapok has been mainly centred on the floss alone. But since the use of the seeds as a source of oil and cake has been recognized, the value of these products needs to be taken into consideration.

The exports of kapok seed from the Dutch East Indies is nearly 15,000 tons valued at about £98,000 annually. This is equivalent to Rs. 4-5 per cwt.

The seed is a source of oil which is used largely in Holland for edible purposes as well as for soap-making, and closely resemble ordinary cotton seed oil in general characters.

The cake obtained after the extraction of oil is reported to be a fairly good feeding stuff, used chiefly in compounding feeding cakes for stock. It is rich in constituents of manurial value as shown by the following analysis :—

| | | | | Per cent. |
|---|---|---|---|---|
| Nitrogen | ... | ... | ... | 4·5 |
| Phosphoric acid | ... | ... | ... | 1·6 |
| Potash | ... | ... | ... | 1·6 |

which when compared with groundnut cake is worth about Rs. 120 per ton.

An acre in full bearing at the age of ten years should yield about 10 cwt. of seed, which would give about 7-8 cwt. of cake having a manurial value of about Rs. 30.

There is a steady market in the United Kingdom for kapok seed.

## EXPORTS FROM CEYLON

The exports of kapok (floss) from Ceylon in 1927 amounted to 3,320 cwt. valued at Rs. 235,248, but reports indicate that very greatly increased quantities of kapok could be readily absorbed by the world's market if they were available.

# LINSEED OIL AS AN ADHESIVE FOR BORDEAUX MIXTURE*

EVER since the time that spraying against coffee and areca diseases was introduced by the Department in Mysore, experiments alike in the laboratory and the field, were being conducted with the object of finding out a cheap and efficient adhesive for use with the spray mixture. The use of an adhesive is necessary owing to the advantage that it not only helps in the uniform spread of the mixture over the sprayed surface, but it prevents the mixture from being washed off by the heavy rains. If it were not for the use of an adhesive with the mixture, spraying work in the malnad before the monsoon, over large areas of coffee and areca would be much less efficient in its results. By using a good adhesive there is not only economy in the quantity of materials used in spraying but also necessarily of a good deal of time and labour.

Very successful results have been achieved hitherto by using lime caseinate as an adhesive. This adhesive has been taken up by most of the areca garden-owners and coffee planters and has practically displaced the resin-soda adhesive originally advocated by the Department.

Preliminary trials in the use of linseed oil as an adhesive in the spray mixtures were made during the monsoon season at Talaguppa. The oil was added at the rate of four fluid ounces to each pound of solid matter contained in the mixture. To 2% bordeaux containing 5 lb. copper sulphate, 5 lb. lime, 25 gallons of water, forty ounces of oil were added. The mixture was well stirred and sprayed on glass plates and, after drying, placed outside in the heavy rains. At the same time mixtures, to which only twenty ounces and ten ounces of oil were added, were sprayed on glass plates and subjected to the heavy rain.

After some time during which twenty-six inches of rainfall were recorded, the mixture was found to be adhering all right to the plates.

The following proportions were tried :—

| Bordeaux | | Oil added | | Mixture on glass plate |
|---|---|---|---|---|
| 5·5·25 | ... | 40 ounces | ... | Intact |
| 5·5·25 | ... | 20 ounces | ... | do |
| 5·5·25 | ... | 10 ounces | ... | do |
| 5·5·25 | ... | 20 ounces | ... | do |
| 5·5·25 | ... | 10 ounces | ... | do |

Casein bordeaux and bordeaux without any adhesive were also used for comparison. When the oil was added to the mixture it was found that the excess oil floated to the surface. The quantity of linseed oil to be used has no bearing to the quantity of water used in the mixture, but it has a relation to the quantity of solids used. Preliminary trials of spraying on arecanuts and coffee leaves were found to be very promising. When compared to casein bordeaux, it was found that the linseed oil bordeaux was not so easily dislodged. Further experiments are under way to see how this mixture will work under field conditions.

*Note.*—Since the above was written, reports have been received that spraying with Linseed oil-bordeaux on areca trees in the malnad, and on coffee, has given promising results.

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* By M. J. N. in *The Journal of the Mysore Agricultural and Experimental Union*, Vol. X, No. 3. 1929.

# MEETINGS, CONFERENCES, ETC.

## KANDY DISTRICT AGRICULTURAL COMMITTEE

MINUTES of the Meeting of the Kandy District Agricultural Committee held at the Kandy Kachcheri on 9th November, 1929, at 11 a.m.

Present :—The Government Agent, C. P., (Chairman), J. C. Ratwatte Adigar, Dr. T. B. Kobbekaduwa, Messrs. Gordon Pyper, G. Harbord, Divisional Agricultural Officer, W. Madawala, Ratemahatmaya, Tumpane, T. B. Mampitiya, Ratemahatmaya, Yatinuwara, T. B. Ratwatte, Ratemahatmaya, Pata Dumbara, M. B. Panabokke, Ratemahatmaya, Udapalata and L. B. Warakaulle, Acting Ratemahatmaya, Pata Hewaheta.

1. Confirmed minutes of the last meeting.
2. Recommended that Dr. T. B. Kobbekaduwa be nominated to be a member of the Board of Agriculture.
3. Resolved that the Teldeniya Market Show, postponed from 1929, be held in 1930.
4. Re allocation of votes, it was resolved to organize the following Competitions :—

   (a) Best Tea Garden in Yatinuwara, Udunuwara and Udapalata under 5 acres and over one acre in extent :—

   3 prizes for each division :—

   | | | |
   |---|---|---|
   | 1st prize | Rs. 40/- | Rs. 270/- |
   | 2nd prize | ,, 30/- | |
   | 3rd prize | ,, 20/- | |

   (b) Paddy Sheaf Competition (best earheads),each sheaf not to consist of less than 100 stalks, for Tumpane and Yatinuwara.

   3 prizes for each division :—

   | | | |
   |---|---|---|
   | 1st prize | Rs. 25/- | Rs. 100/- |
   | 2nd prize | ,, 15/- | |
   | 3rd prize | ,, 10/- | |
   | Printing etc. | | Rs. 130/- |

H. W. Codrington,
Chairman of the Committee.

# COLOMBO DISTRICT FOOD PRODUCTION COMMITTEE

MINUTES of a meeting of the Food Production Committee of the Colombo District held at the Colombo Kachcheri on the 28th November 1929, at 2 p.m.

*Present* :—The Assistant Government Agent, Mr H. P. Kaufmann, in the chair, and Mr. W. Samarasinghe, Atâpattu Mudaliyar; Mr. W. R. Illangakoon, Mudaliyar of Colombo; Mr. T. P. Abeyakoon, Mudaliyar of Alutkuru Korale South; Mr. G. F. Fonseka, Mudaliyar of Salpiti Korale; Mr. Maurice Perera, Mudaliyar of Siyane Korale West; Mr. J. Eric Perera, Mudaliyar of Siyane Korale East; Mr. Joseph Perera, Muhandiram of Hapitigam Korale acting for the Mudaliyar; Gate Mudaliyar C. H. A. Samarakkody, Mudaliyar of Alutkuru Korale North; and the Divisional Agricultural Officer (Mr. Ashmore Peiris).

1. Minutes of the previous meeting were read and confirmed.

2. A suggestion from the Divisional Agricultural Officer that a competition be held in each Mudaliyar's Division for Pure-Line Paddy, to be supplementary to other competitions to be held in 1930, was approved. The paddy crop will be Maha Crop, and accordingly it could be judged only early in 1931.

3. The following competitions were decided on for the year, viz :—

| | |
|---|---|
| In Alutkuru Korale North | Tobacco Competition |
| In Alutkuru Korale South | Plantain Garden |
| In Colombo Mudaliyar's Division | Vegetable Garden |
| In Siyane Korale East | Pineapple |
| In Siyane Korale West | Vegetable Gardens and Plantain Gardens |
| In Hewagam Korale | Plantain Garden |
| In Salpiti Korale | Vegetable Garden |
| In Hapitigam Korale | Vegetable Garden |

4. Decided that judging be held in August-September, that entries should close by the end of March, and that notices be sent in for printing by 15th January, 1930.

5. Decided that for the Paddy Competition of 1931, entries be sent in by 30th June next and that a para. be inserted in the present notice re this Paddy Competition.

6. Resolved that Government Grant of Rs. 400/- be divided equally in 8 allotments of Rs. 50/- each, among the 8 Korales.

H. P. KAUFMANN,
Assistant Government Agent.

# DEPARTMENTAL NOTES

## PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA

### FOR THE MONTHS OF NOVEMBER AND DECEMBER, 1929

### TEA

*Plots under Indigofera endecaphylla*

THE 1929 pruning marked the end of the second inter-pruning period since the planting of *Indigofera*. Pruning was started at the beginning of September, a month earlier than was intended, so that the last period is a month shorter than previous periods. This fact together with the short rainfall in the last period and the loss of a large number of bushes after the 1927 pruning makes the general increase in yields more noteworthy and satisfactory.

Soil samples were taken again at the end of the last period but the results of the analyses are not yet to hand; they will be included in an article in *The Tropical Agriculturist* in which these results will be more fully discussed.

In the following table only the actual yields of the plots are used. The system of calculating yields to a full acre of 2,722 bushes which has frequently been used in the past produces a most irregular set of figures and is thought to be unreliable.

The last two-year inter-pruning period before the planting of *Indigofera* is taken as the standard of comparison and the percentage increases or decreases in the succeeding periods are shown.

Percentage Increase or Decrease in actual Yields of Green Leaf compared with Last Period before planting *Indigofera*.

| Plot. | Acres. | 1925-27. per cent. | 1927-29. per cent. | |
|---|---|---|---|---|
| 141 A | ½ | — 9 | + 4 | Singlo jât |
| 141 B | ½ | — 8 | + 2½ | |
| 142 A | ½ | + ½ | + 10 | |
| 142 B | ½ | — 1 | + 5 | |
| 143 A | ½ | — ½ | + 5 | |
| 143 B | ½ | — 2 | — 4½ | |
| 145 | 1 | — 10 | — 7 | Assam hybrid |
| 146 A | ½ | — 3 | + 4 | Dark leaf Manipuri Plot 149 planted with dadaps. |
| 146 B | ½ | — ½ | + 3 | |
| 147 A | ½ | — 3 | + 5 | |
| 147 B | ½ | + 6 | + 9 | |
| 148 A | ½ | + 8 | + 20½ | |
| 148 B | ½ | + 4 | + 19 | |
| 149 | 1 | + 5 | + 4 | |
| Total | 8 | — 6 | + 4½ | |

The rainfall during the three periods was as follows.

| | | | |
|---|---|---|---|
| 1923-25 (No *Indigofera*) | ... | ... | 198·80 inches |
| 1925-27 (*Indigofera*) | ... | ... | 186·46 ,, |
| 1927-29 (*Indigofera*) | ... | ... | 169·33 ,, |

It is to be noted that the increases shown in the last period are over the 1923-25 periods; the increases of 1927-29 over 1925-27 give in most cases a much higher figure.

The yields of three clean-weeded plots on the station are given below for comparison. They have not received the same manurial treatment—the portions of the plots not under manurial experiment have not been manured at all—and a true comparison cannot be made, but the large decline in yields in the last dry period compared with the general increase in the *Indigofera* plots is worthy of note.

| Plot | Acres | 1925-27 per cent. | 1927-29 per cent. |
|---|---|---|---|
| 144 (dadaps) | 1 | + 3 | — 24½ |
| 150 (Albizzia) | 1 | + 9 | — 41 |
| 155 (No shade) | 1 | — 35 | — 47 |

In the case of plot 155 a large number of bushes were lost after the 1927 pruning. Also the plot has suffered severely from the root action of the old rubber on two sides of it.

It has always been thought that in a dry climate or season the loss of moisture through transpiration from a cover crop might adversely affect the tea. Soil moisture determinations published by the Agricultural Chemist have indicated that at all events after the cover has been established for some time more moisture is retained than is lost, and this is borne out by the yields of these plots. It is probable that the check to the run-off which results in more rainfall entering the ground is an important factor.

### *Manurial Experiment*

The manurial experiments laid down with forty-bush plots after the 1925 pruning were stopped after the 1929 pruning. The experiments were designed on the percentage increase system, that is a comparison of the relative difference between certain plots and control plots before and after manuring. The system is based on the assumption that the differences would have been the same in the second period if manures had not been applied. Researches of the Tea Research Institute into the technique of field experiments with tea have shown this assumption to be unsound. In addition the loss of a certain number of bushes made it necessary to calculate the yields according to the number of bushes remaining and this procedure is also considered unsound. It is therefore regretted that the figures obtained from this experiment cannot be considered reliable and they are not published.

### *Strips of Indigofera in the Hillside Tea*

In August 1927 this area was planted with six-row strips of *Indigofera endecaphylla* alternating with six clean-weeded rows. These strips were not separately plucked but periodical inspections have been made to note any difference in the appearance of the tea. At the last inspection it appeared that the tea under *Indigofera* appeared slightly more vigorous and certainly the young supplies in these strips appeared healthier.

## RUBBER

### *Rejuvenation Experiment*

This experiment started on September 1st. A number of trees have already shown symptoms of brown bast, one or both cuts going dry. In such cases the cut or cuts have been changed over to the other side. If the number of cases increases there seems to be a possibility of the severe daily "tapping to death" defeating its own ends.

There are two cuts on each tree. Below is given the number and percentage of cuts in each plot that had gone dry at the end of December.

| Plot | Number of trees | Number of original cuts | Method of tapping original cuts | Bark consumption per month Inches | Number of cuts dry | Per cent. cuts dry |
|---|---|---|---|---|---|---|
| 1 | 68 | 136 | Half circumference daily to the wood. | 2 | 32 | 23·5 |
| 2 | 76 | 152 | do | $1\frac{2}{3}$ | 36 | 20·0 |
| 3 | 43 | 86 | do | $1\frac{1}{12}$ | 19 | 23·2 |
| 4 | 40 | 80 | Daily on alternate months. Fine tapping but not to the wood. | $1\frac{2}{3}$ | 1 | 1·2 |

These figures show clearly that severe daily tapping to the wood brings on brown bast in a very short time.

## *New Manurial Experiment.*

The following is the plan of a new manurial experiment which was decided on early in 1929.

1. The experiment to be called the "New Avenue Rubber Manurial Experiment."
2. Twenty plots, each containing 20 tappable trees, to be laid out before April 1st, 1930. The plots to be arranged in five blocks of four plots each, the position of the plots in the blocks being randomised.
3. The plots to be named as under and to receive the manurial treatment shown.

   2 N Plots. (5 plots) 4 lb. sulphate of ammonia per tree = 80 lb. per plot = 80 lb. N per 100 trees.

   N Plots. (5 plots) 2 lb. sulphate of ammonia per tree = 40 lb. per plot = 40 lb. N per 100 trees.

   N Ph. P. Plots. (5 plots) 2 lb. sulphate of ammonia per tree = 40 lb. per plot = 40 lb. N per 100 trees. 2·2 lb. superphosphate per tree = $44\frac{1}{2}$ lb. per plot = 40 lb. $P_2O_5$ per 100 trees. ·8 lb. muriate of potash per tree = 16 lb. per plot = 40 lb. $K_2O$ per 100 trees.

   C Plots. Same cultural treatment as other plots but no manures. Above manures to be broadcasted down the middle of the avenues and forked in with envelope-forking once annually in the month of December.
4. Manures to be first applied in the month of December, 1929.
5. Tapping to commence on April 1st, 1930, and the year for purposes of recording yields to be from April 1st to March 31st. Tapping to be on alternate days throughout the year on the half circumference; lower end of cut to be 24 inches from the ground. Bark allowance, 6 ins. per annum.
6. 2 N Plots to be marked with a double green band.

   N ,, ,, ,, ,, ,, a green band.

   N Ph. P Plots to be marked with a green band, a red band, and a black band.

   C ,, ,, ,, ,, ,, a white band.

7. Every plot to have a number in addition to the letters denoting the treatment. Yields of dry rubber (sheet or biscuits + scrap) to be separately recorded for each plot.

8. A space of 40 ft. and a drain already exist between avenues. Two pairs of trees and a drain dug between these two pairs of trees to be left to separate the end of the plots in the avenues.

The plots were marked out, the dividing drains dug, and the manures applied in December 1929.

### *Import of Budded Stumps*

The following is a complete list of foreign budded stumps imported in 1929.

| Mother-Tree | | Number of stumps | Number arrived dead | Number planted |
|---|---|---|---|---|
| Tjirandji 1 | ... | 100 | — | 100 |
| Tjirandji 8 | ... | 200 | — | 200 |
| Tjirandji 16 | ... | 200 | — | 200 |
| AVROS 49 | ... | 150 | 5 | 145 |
| AVROS 50 | ... | 150 | 15 | 135 |
| Bodjong Datar 5 | ... | 150 | 20 | 130 |
| | | | | 910 |

## CACAO

The autumn crop was a heavy one and absorbed a great deal of labour in November and December.

At the request of the Director, Royal Botanic Gardens, Kew, trees bearing little or no crops have been marked for observation. If failure to bear a crop is found to be permanent, a botanical examination of the cause will be attempted.

## COFFEE

The coffee year ended on September 30th and the yields for the last six years are published below.

### *Robusta Types*

Pounds fresh berries per bush

| Year | Robusta | Uganda | Quillou | Canephora | Hybrid. |
|---|---|---|---|---|---|
| 1923-24 | 2·37 | 3·43 | 6·91 | 3·01 | 8·38 |
| 1924-25 | 4·01 | 5·29 | 3·43 | 3·88 | 5·62 |
| 1925-26 | 3·23 | 2·06 | 3·91 | 3·09 | 9·78 |
| 1926-27 | 8·54 | 8·99 | 5·01 | 10·29 | 7·61 |
| 1927-28 | 5·57 | 6·86 | 13·45 | 7·63 | 8·26 |
| 1928-29 | 7·44 | 6·69 | 6·18 | 8·55 | 5·19 |
| Average | 5·19 | 5·55 | 6·45 | 6·05 | 7·47 |

### *Liberian Types*

Pounds fresh berries per bush

| Year | Excelsa | Abeokuta | Liberia Pasir Pogor | Kleinii | Arnoldiana |
|---|---|---|---|---|---|
| 1923-24 | 5·56 | 9·16 | 6·68 | — | — |
| 1924-25 | 19·82 | 12·84 | 13·34 | — | — |
| 1925-26 | 14·00 | 15·26 | 11·71 | — | — |
| 1926-27 | 25·80 | 18·94 | 21·21 | — | — |
| 1927-28 | 19·75 | 17·77 | 12·76 | 6·54 | 2·00 |
| 1928-29 | 22·00 | 31·20 | 27·16 | 2·54 | 2·50 |
| Average | 17·82 | 17·53 | 15·47 | 4·54 | 2·75 |

### *Arabian Types*

Pounds fresh berries per bush.

| Year | | Arabica Plot 140 I | Kent's | Jackson's Hybrid. |
|---|---|---|---|---|
| 1923-24 | ... | 2·39 | — | — |
| 1924-25 | ... | 2·39 | ·64 | ·18 |
| 1925-26 | ... | 2·00 | 1·34 | 1·39 |
| 1926-27 | ... | 3·26 | ·21 | ·58 |
| 1927-28 | ... | 1·27 | ·69 | ·15 |
| 1928-29 | ... | 1·93 | 1·84 | ·76 |
| Average | ... | 2·20 | ·94 | ·61 |

The yields from the variety given under the name of Hybrid are not strictly comparable since this coffee only is being grown without shade and some of the bushes are very widely spaced (round the show plots) while others are very closely planted. The bushes from which the other yields are obtained are all grown under shade. They are not all of the same age but are all in full bearing. 10 ft. × 10 ft. is considered a suitable planting distance for the Robusta types and such a planting will give 435 bushes per acre. The out-turn of parchment coffee to fresh berries may be taken at 22 per cent. and on this basis the average yields of the Robusta types for the last six years work out as follows.

| Variety | | | Cwt. dry parchment coffee per acre |
|---|---|---|---|
| Robusta | ... | ... | 4·44 |
| Uganda | ... | ... | 4·74 |
| Quillou | ... | ... | 5·51 |
| Canephora | ... | ... | 5·17 |
| Hybrid | ... | ... | 6·38 |

These yields are calculated on the assumption that there are no vacancies but they give a general idea of the cropping capacity of the Robusta types at Peradeniya.

Prices realised for coffee at an auction sale in December were higher than usual.

| | | | |
|---|---|---|---|
| Sun-dried Robusta | ... | ... | 32 cents per lb. |
| Robusta parchment | ... | ... | 46 ,, ,, ,, |
| Sun-dried Liberian | ... | ... | 16 ,, ,, ,, |

## GREEN MANURES AND COVER CROPS

It has been previously reported that leeches were not found in *Indigofera endecaphylla.* After the heavy rain in November however a considerable number of leeches was found in this cover.

*Gliricidia sepium* trees in the six-acre coffee field in the Terraced Valley which had been left unlopped for a number of months were observed in November to be severely attacked by green bug. The pest had spread to the coffee and, in the Terraced Valley, to *Hydnocarpus Whightiana.* Lopping of the *Gliricidia* was at once started.

## FODDER PLANTS

At the end of 1928 a piece of the grazing area used by the Kangayam cattle was fenced off and planted with *Indigofera endecaphylla* for trial as a grazing plant. The fence was removed in November 1929 and for two days the whole herd congregated on this patch and grazed it off clean. There is no doubt as to the liking of the cattle for the plant and it now remains to see whether the plant will stand the treatment.

## FRUIT

Observations over a number of years indicate that grape fruit trees on the station come into bearing at about 8 years of age and at 18 to 20 years their useful life is past and deterioration sets in. This applies to seedling trees: it is possible that different results will be obtained with some of the imported budded material now coming on.

The general condition of all other citrus fruit trees on the station is very poor.

## MISCELLANEOUS

A trial with Atlas Tree Killer on three sapu trees has shown that stripping the bark from a ring six inches wide and painting on the Tree Killer resulted in the complete death of the tree in a month. Drilling holes and pouring in the Tree Killer appears to result in slower death.

The Soil Erosion Committtee visited the station on December 11th.

## THE IRIYAGAMA DIVISION

The decisions of the last (and it is to be hoped final) Committee on the plans of this division have rendered necessary a complete reorganisation of the areas, blocks, and plots in the 50 acres opened in 1927 and 1928. This cannot be started until the plan made by the Survey Department comes to hand. Moreover, the decision to reduce by half the size of the clones has correspondingly enlarged the number of mother-trees to be tested with the result that it may be difficult to obtain bud-wood of sufficient mother-trees for the 50 acres already opened, while 14 out of the 20 acres cleared and holed early in 1929 to be planted with 1929 seed at stake are going back into jungle and will have to be cleared again at some future date.

The new area 6 (planted with foreign budded stumps) was manured with nitrogenous and phosphatic manures in November and December.

The number of stumps of which the buds had shot by the end of the year is shown below. The buds of the remainder are alive.

| Clone | Date of planting | Number of plants planted | Number sprouted by 31-12-29 |
|---|---|---|---|
| Tj 1 | 29-10-29 | 60 | 46 |
| Tj 8 | 29-10-29 | 60 | 24 |
| Tj 16 | 9-11-29 | 60 | 6 |
| BD 5 | 12-10-29 | 60 | 24 |
| AVROS 49 | 12-10-29 | 60 | 22 |
| AVROS 50 | 12-10-29 | 60 | 15 |
| SR 9 | 5th to 21st Nov. 1929 | 60 | 19 |
| H 2 | 8th to 21st Nov. 1929 | 60 | 29 |

Paths were dug to connect up all individual terraces in the portions of the land thus terraced. These have the double object of connecting up the individual terraces so that continuous terraces may be shown and lettered on the plan, and of facilitating movement from one terrace to another. The paths have been sloped back into the land like miniature terraces.

The extraction of stumps was resumed in December after an interval of several months and 5 acres had been completed by the end of the year.

The building of stone steps was also resumed. These are following the temporary earth paths and steps cut during the year since the latter have been marked on the plan.

The position as regards the imported foreign budded stumps in the bud-wood nursery at the end of the year was as follows :—

| Clone | | Number of plants | Number of which buds had shot |
|---|---|---|---|
| AVROS 49 | ... | 74 | 29 |
| AVROS 50 | ... | 74 | 8 |
| Tj 1 | ... | 30 | 8 |
| Tj 8 | ... | 129 | 11 |
| Tj 16 | ... | 130 | 2 |
| BD 5 | ... | 60 | 7 |

The buds of the remainder are alive.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

# SCHNEIDER CHALLENGE CUP COMPETITION

THE competitoin organised among registered school gardens in the Central Division of the Department of Agriculture for a challenge cup offered by Sir G. S. Schneider was held for the second year in succession in 1929 when 64 entries were registered from Kandy, Nuwara Eliya, Matale and Kegalle districts, which is more than double the entries of the previous year. The increase in numbers is an indication of the enthusiasm that has been infused into the teachers and pupils of the schools which possess registered gardens by the offer of this cup for competition.

This is an incentive to satisfactory garden work, and reports on the competition show that marked improvement has been noticed in the work carried out in the various schools. Particular attention was paid to the different sections of the gardens; terracing, laying out of beds, manuring and grouping of crops had been carried out commendably. A noticeable feature was the establishment of live hedges and fruit nurseries in a number of gardens. Most of the gardens are now in a position to issue regular supplies of fruit plants to pupils for their home gardens.

From the commencement of the competition, instructions and advice were given to the competitors by the officer-in-charge of school gardens at intervals, who also carried out the preliminary judging. At the final judging, K/Nugawela Government Vernacular Boys' School Garden was adjudged the winner of the trophy with 95 out of a possible 100 points, closely followed by KG/Beddewela G. V. B. S. and K/Alawatugoda G. V. B. S. which tied for the second place with 91.

The winning school is entitled to a replica of the cup for retention. K/Nugawela was the successful school last year also.

# CHILLIE CULTIVATION COMPETITION HELD IN THE JAFFNA DISTRICT

A chillie cultivation competition was organised in the Jaffna district for the third year in 1929. The plots were tidy and clean, and the general level of cultivation was better than last year.

The final judging was done by the Divisional Agricultural Officer, Northern, assisted by an Agricultural Instructor and an experienced cultivator, and the following have been adjudged prize-winners :—

| | | | |
|---|---|---|---|
| 1. | Vaithianather Eliyathambi of Anaicottai | ... | Rs. 30·00 |
| 2. | Nagamuttu Ramapillai of Kokuvil West | ... | Rs. 25·00 |
| 3. | V. Karthigesu, Police Vidane of Alaveddy | ... | Rs. 20·00 |
| 4. | Kasipillai Thamotherampillai of Alaveddy | ... | Rs. 15·00 |
| 5. | Arumugam Venatagapillai of Suthumalai North | | Rs. 7·50 |

# REVIEW

## TEA AND TEA DEALING *

THOUGH primarily designed as a handbook for the guidance of those who intend embarking on the career of a tea dealer, this recent addition to existing literature on tea provides interesting reading for anyone who is concerned with the industry whether as a broker, a shareholder, or planter and perhaps especially for the latter, as it deals with the phase with which he is probably least familiar, namely the handling of the product after it reaches its destination in London.

In his treatment of the subject, the author is to be congratulated on having condensed in very readable form a summary of the history of the tea planting industry in those countries with which it is essentially connected, an account of the general method of cultivation and manufacture, and the final treatment of the manufactured article before it reaches the consumer.

The chapter on production and consumption is judiciously illustrated with interesting statistics, one table shewing the precentage shares of India, Ceylon and other producers in the import trade of the chief consuming countries. In this connection the author alludes to the good results which have attended the strenuous selling efforts made by India and Ceylon, a remark which may come as a surprise to ardent propagandists in this Island, though it is certainly true that the percentage of Ceylon imports into America has increased by 14% between 1913 and 1927.

In a brief summary of the development of the tea industry in Ceylon the statement is made that for the most part tea plants are to be found at an elevation of about 3,000 feet, which perhaps hardly does justice to the large acreage of high-grown tea which contributes so largely to the market average maintained by the Ceylon product.

After a chapter on office routine the book closes with some sound words of advice on salesmanship and the duties of the employer to the employee which are of universal application.

The appendix of extracts from the Report by the Food Council to the President of the Board of Trade made in 1926 is of particular interest at a time when restriction of output is again being contemplated.—A. G. Baynham.

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* Tea and Tea Dealing by F. W. F. Staveacre, London: Sir Isaac Pitman & Sons, Ltd., 1929. 7*s*. 6*d*.

# ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1930.

| Province, &c. | Disease | No. of Cases up to date since Jan. 1st 1930 | Fresh Cases | Recoveries | Deaths | Balance Ill | No. Shot |
|---|---|---|---|---|---|---|---|
| Western | Rinderpest | 54 | 54 | 11 | 30 | 4 | 9 |
| | Foot-and-mouth disease | 8 | 8 | 8 | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Piroplasmosis | ... | ... | ... | ... | ... | ... |
| | Rabies. (Dogs) | ... | ... | ... | ... | ... | ... |
| Colombo Municipality | Rinderpest | .. | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 1 | 1 | 1 | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Haemorrhagic septicaemia | 2 | 2 | ... | 2 | ... | ... |
| | Black Quarter | 2 | 2 | ... | 2 | ... | ... |
| | Rabies (Dogs) | 3 | 3 | ... | 3 | ... | ... |
| Cattle Quarantine Station | Rinderpest | . | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | ... | .. | ... | ... | ... | ... |
| | Anthrax (Goats) | 48 | 48 | ... | 48 | ... | ... |
| Central | Rinderpest | ... | .. | ... | ... | ... | — |
| | Foot-and-mouth disease | 170 | 170 | ... | 2 | 168 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | 1 | 1 | ... | ... | ... | 1 |
| | Haemorrhagic septicaemia | ... | .. | ... | ... | ... | ... |
| Southern | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 36 | 36 | 27 | ... | 9 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| Northern | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 788 | 788 | 107 | 1 | 680 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| Eastern | Rinderpest | ... | .. | ... | ... | ... | ... |
| | Foot-and-mouth disease | 73 | 73 | 66 | 2 | 5 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| North-Western | Rinderpest | 550 | 550 | 22 | 150 | 10 | 368 |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | .. |
| | Anthrax | ... | ... | ... | .. | ... | ... |
| | Piroplasmosis | | | | | | |
| North-Central | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 563 | 563 | 276 | 5 | 282 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| Uva | Rinderpest | FREE | | | | | |
| | Foot-and-mouth disease | | | | | | |
| | Anthrax | | | | | | |
| | Haemorrhagic septicaemia | | | | | | |
| Sabaragamuwa | Rinderpest | 19 | 19 | 3 | 16 | ... | ... |
| | Foot-and-mouth disease | 683 | 683 | 417 | 3 | 263 | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Haemorrhagic septicaemia | 8 | 8 | ... | 8 | ... | ... |

G. V. S. Office,
Colombo, 7th February, 1930.

G. W. STURGESS,
Government Veterinary Surgeon.

# METEOROLOGICAL.

## JANUARY, 1930.

| Station | Temperature | | Mean Humidity | Mean amount of Cloud 0=clear 10=overcast | Mean Wind Direction during Month | Daily Mean Velocity | Rainfall | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean Daily Shade | Difference from Average | | | | | Amount | No. of Rainy Days | Difference from Average |
| | ° | ° | % | | | Miles | Inches | | Inches |
| Colombo Observatory | 79·0 | +0·4 | 76 | 5·1 | N | 117 | 5·75 | 11 | + 1·93 |
| Puttalam | 77·4 | +0·5 | 80 | 5·6 | NNE | 105 | 2·22 | 12 | — 0·57 |
| Mannar | 78·3 | 0 | 82 | 6·6 | NNE | 194 | 4·21 | 12 | + 1·42 |
| Jaffna | 76·6 | —0·2 | 83 | 6·8 | NE | 49 | 16·89 | 12 | + 14·25 |
| Trincomalee | 77·5 | —0·1 | 81 | 5·9 | NNE | 120 | 12·45 | 15 | + 5·89 |
| Batticaloa | 77·0 | 0 | 85 | 6·2 | N | 175 | 11·25 | 16 | + 1·01 |
| Hambantota | 79·0 | +0·6 | 78 | 4·1 | NE | 285 | 1·03 | 8 | — 2·40 |
| Galle | 79·0 | +1·0 | 80 | 5·2 | Var: | 110 | 3·71 | 7 | — 0·45 |
| Ratnapura | 80·6 | +1·3 | 74 | 4·8 | — | — | 6·37 | 15 | + 0·83 |
| Anu'pura | 76·0 | —0·5 | 84 | 6·4 | — | — | 3·08 | 15 | — 0·88 |
| Kurunegala | 78·1 | +0·5 | 76 | 5·8 | — | — | 4·97 | 12 | + 1·19 |
| Kandy | 75·1 | +1·3 | 74 | 4·5 | — | — | 11·87 | 14 | + 6·64 |
| Badulla | 70·4 | +0·6 | 84 | 5·7 | — | — | 6·76 | 17 | — 2·84 |
| Diyatalawa | 65·3 | +1·2 | 79 | 5·9 | — | — | 4·74 | 13 | — 1·25 |
| Hakgala | 60·1 | +1·1 | 82 | 5·0 | — | — | 12·28 | 20 | + 2·32 |
| N'Eliya | 56·8 | +0·4 | 80 | 5·6 | — | — | 6·95 | 16 | + 1·20 |

There was considerable rain during the first half of the month and very little in the second half. The resulting total for the whole month was well above average in the extreme north and along the north-east coast. The average was passed at nearly all stations in Sabaragamuwa and at the majority of those in the W.P. and C.P. In the N.W.P. small excesses and small deficits were about equally divided. In Uva and the S. P. deficits were in the majority, while in the N. C. P. and the part of the E. P. south of Batticaloa, practically all stations were in deficit.

The highest totals were St. Martin's (Upper) 36·10 and Hendon 30·37 both of which are below their January averages. Other stations with over 20 inches were Allai, Arawa, Deanstone, Dooroomadella and Uva Estate.

Falls of over 6 inches in a day were reported from Mahaoya (7·40 on the 9th), Iranamadu (6·99 on 3rd), Tonigala (6·70 on 17th) and at Point Pedro, Kayts and Sigiri.

Temperatures were on the whole above their averages and wind velocities in all cases below theirs.

Conditions in the latter half of the month can be roughly described as more typical of February than January, so that, as in the case of December, the weather may be summarised as rather ahead of its normal time-table.

A. J. BAMFORD,
*Supdt., Observatory.*